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NEW CHAPTERS IN THE WARFARE OF SCIENCE.

XVIII.—FROM MAGIC TO CHEMISTRY AND PHYSICS.

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PART I.

IN all the earliest developments of human thought we find a tendency to ascribe mysterious powers over Nature to men and women especially gifted or skilled. Survivals of this view are found to this day among savages and barbarians left behind in the evolution of civilization, and especially is this the case among the tribes of Australia, Africa, and the Pacific coast of America; even in the most enlightened nations still appear, here and there, popular beliefs, observances, or sayings, drawn from this earlier phase of thought.

Between the prehistoric savage developing this theory, and therefore endeavoring to deal with the powers of Nature by magic, and the modern man who has outgrown it, appears a long line of nations struggling upward through it. As the hieroglyphs, cuneiform inscriptions, and various other records of antiquity are read, the development of this belief can be studied in Egypt, India, Babylonia, Assyria, Persia, and Phœnicia. From these countries it came into the early thought of Greece and Rome, but especially into the Jewish and Christian sacred books; both in the Old Testament and in the New we find magic, sorcery, and soothsaying constantly referred to as realities.*

* For magic in prehistoric times and survivals of it since, with abundant citation of authorities, see Tylor, Primitive Culture, chap. iv; also the Early History of Mankind, by

The first distinct impulse which lifted mankind toward a higher view of research into natural laws was given by the philosophers of Greece. It is true that philosophical opposition to physical research was at times strong, and that even a great thinker like Socrates considered certain physical investigations as an impious intrusion into the work of the gods; it is also true that Plato and Aristotle, while bringing their thoughts to bear upon the world with great beauty and force, did much to draw mankind away from those methods which in modern times have produced the best results.

Plato developed a world in which the physical sciences had little if any real reason for existing; Aristotle, a world in which the same sciences were developed not so much by observation of what is, as of speculation on what ought to be. From the former of these two great men came into Christian theology many germs of mediæval magic, and from the latter sundry modes of reasoning which aided in the evolution of these; yet the impulse to human thought given by these great masters was of inestimable value to our race, and one legacy from them was especially precious;—the idea that a science of Nature is possible, and that the highest occupation of man is the discovery of its laws. Still another gift from them was greatest of all, for they gave scientific freedom: they laid no interdict upon new paths; they interposed no barriers to the extension of knowledge; they threatened no doom in this life or in the next against investigators on new lines; they left the world free to seek any new methods and to follow any new paths which thinking men could find.

This legacy of belief in science, of respect for scientific pursuits, and of freedom in scientific research, was especially received by the school of Alexandria, and above all by Archimedes,

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the same author, third edition, pp. 115 *et seq.*, also p. 380; also Andrew Lang, Myth, Ritual, and Religion, vol. i, chap. iv. For magic in Egypt, see Lenormant, Chaldean Magic, chaps. vi–viii; also Maspero, Histoire Ancienne des Peuples de l'Orient; and especially the citations from Chabas, Le Papyrus Magique Harris, in chap. vii; also Maury, La Magie et l'Astrologie dans l'Antiquité et au Moyen Age. For magic in Chaldea, see Lenormant as above. For examples of magical powers in India, see Max Müller's Sacred Books of the East, vol. xvii, pp. 121 *et seq.* For a legendary view of magic in Media, see the Zend Avesta, Part I, p. 14, translated by Darmsteter; and for a more highly developed view, see the Zend Avesta, Part III, p. 239, translated by Mill. For magic in Greece and Rome, and especially in the Neoplatonic school as well as in the middle ages, see especially Maury, La Magie et l'Astrologie, chaps. iii–v. For various sorts of magic recognized and condemned in our sacred books, see Deuteronomy, xviii, 10, 11; and for the burning of magical books at Ephesus under the influence of St. Paul, see Acts, xix, 14. See also Ewald, History of Israel, Martineau's translation, fourth edition, ii, 55–63; iii, 45–51. For a very elaborate summing up of the passages in our sacred books, recognizing magic as a fact, see De Haen, "De Magia," Lips., 1775, chaps. i, ii, and iii, of first part. For general subject of magic, see Ennemoser, History of Magic, translated by Howitt, which, however, constantly mixes sorcery with magic proper.

who began, just before the Christian era, to open new paths through the great field of the inductive sciences by observation, comparison, and experiment.*

The establishment of Christianity, though it began a new evolution of religion, arrested the normal development of the physical sciences for over fifteen hundred years. The cause of this arrest was twofold: First, there was created an atmosphere in which the germs of physical science could hardly grow;—an atmosphere in which all seeking for truth in Nature as truth was regarded as futile. The general belief derived from the New Testament Scriptures was, that the end of the world was at hand; that the last judgment was approaching; that all existing physical Nature was soon to be destroyed: hence, the greatest thinkers in the Church generally poured contempt upon all investigators into a science of Nature, and insisted that everything except the saving of souls was folly.

This belief appears frequently through the entire period of the middle ages, but during the first thousand years it is clearly dominant. From Lactantius and Eusebius, in the third century, pouring contempt, as we have seen, over studies in astronomy, to Peter Damian, the noted chancellor of Pope Gregory VII, in the eleventh century, declaring all worldly sciences to be "absurdities" and "fooleries," it becomes the atmosphere of thought.†

Then, too, there was established a standard to which all science which did struggle up through this atmosphere must be made to conform—a standard which favored magic rather than science, for it was a standard of rigid dogmatism obtained from literal readings in the Jewish and Christian Scriptures. The most careful inductions from ascertained facts were regarded as wretchedly fallible when compared with any view of Nature whatever given or even hinted at in any poem, chronicle, code, apologue, myth, legend, allegory, letter, or discourse of any sort which had happened to be preserved in the literature which had come to be held as sacred.

For twelve centuries, then, the physical sciences were thus dis-

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* As to the beginnings of physical science in Greece, and of the theological opposition to physical science, also Socrates's view regarding certain branches as interdicted to human study, see Grote's Greece, vol. i, pp. 495 and 504, 505; also Jowett's introduction to his translation of the Timæus, and Whewell's History of the Inductive Sciences. For examples showing the incompatibility of Plato's methods in physical science with that pursued in modern times, see Zeller, Plato and the Older Academy, English translation by Alleyne and Goodwin, pp. 375 *et seq.* The supposed opposition to freedom of opinion in the "Laws" of Plato, toward the end of his life, can hardly make against the whole spirit of Greek thought.

† For the view of Peter Damian and others through the middle ages as to the futility of scientific investigation, see citations in Eicken, Geschichte und System der mittelälterlichen Weltanschauung, chap. vi.

couraged or perverted by the dominant orthodoxy. Whoever studied Nature studied it either openly to find illustrations of the sacred text, useful in the "saving of souls," or secretly to gain the aid of occult powers, useful in securing personal advantage. Great men like Bede, Isidore of Seville, Rabanus Maurus, accepted the scriptural standard of science, and used it as a means of Christian edification. The views of Bede and Isidor on kindred subjects have been shown in former chapters; and typical of the view taken by Rabanus is the fact that in his great work on the Universe there are only two chapters which seem directly or indirectly to recognize even the beginnings of a real philosophy of Nature. A multitude of less-known men found warrant in Scripture for magic applied to less worthy purposes.*

But after the thousand years to which the Church, upon supposed scriptural warrant, had lengthened out the term of the earth's existence had passed, "the end of all things" seemed further off than ever; and in the thirteenth century, owing to causes which need not be dwelt upon here, came a great revival of thought, so that the forces of theology and of science seemed arrayed for a contest. On one side came a revival of religious fervor, and to this day the works of the cathedral-builders mark its depth and strength; on the other side came a new spirit of inquiry incarnate in a line of powerful thinkers.

First among these was Albert of Bollstadt, better known as Albert the Great, the most renowned scholar of his time. Fettered though he was by the methods sanctioned in the Church, dark as was all about him, he had conceived ideas of better methods and aims; his eye pierced the mists of scholasticism; he saw the light, and sought to draw the world toward it. He stands among the great pioneers of physical and natural science; he aided in giving foundations to botany and chemistry; he rose above his time and struck a heavy blow at those who opposed the possibility of human life on opposite sides of the earth; he noted the influence of mountains, seas, and forests upon races and products, so that Humboldt justly finds in his works the germs of physical geography as a comprehensive science.

But the old system of deducing scientific truth from scriptural texts was renewed in the development of scholastic theology,

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* As typical examples, see the utterances of Eusebius and Lactantius regarding astronomers given in the chapter on Astronomy. For a summary of Rabanus Maurus's doctrine of physics, see Heller, Geschichte der Physik, vol. i, pp. 172 *et seq.* For Bede and Isidore, see the earlier chapters of this work. For an excellent statement regarding the application of scriptural standards to scientific research in the middle ages, see Kretschmer, Die physische Erdkunde im Christlichen Mittelalter, pp. 5 *et seq.* For the distinctions in magic recognized in the mediæval Church, see the long catalogue of various sorts given in the Abbé Migne's Encyclopédie Théologique, third series, article "Magie."

and ecclesiastical power acting through thousands of subtle channels was made to aid this development. The old idea of the vast superiority of theology was revived. Though Albert's main effort was to Christianize science, he was dealt with by the authorities of the Dominican order, subjected to suspicion and indignity, and only escaped persecution for sorcery by yielding to the ecclesiastical spirit of the time, and working finally in theological channels by scholastic methods.

It was a vast loss to the earth; and certainly, of all organizations that have reason to lament the pressure of ecclesiasticism which turned Albert the Great from natural philosophy to theology, foremost of all in regret should be the Christian Church, and especially the Roman branch of it. Had there been evolved in the Church during the thirteenth century a faith strong enough to accept the truths in natural science which Albert and his compeers could have given, and to have encouraged their growth, this faith and this encouragement would to this day have formed the greatest argument for proving the Church directly under divine guidance; they would have been among the brightest jewels in her crown. The loss to the Church by this want of faith and courage has proved in the long run even greater than the loss to science.*

The next great man of that age whom the theological and ecclesiastical forces of the time turned from the right path was Vincent of Beauvais. During the first half of the twelfth century he devoted himself to the study of Nature in several of her most interesting fields. To astronomy, botany, and zoölogy he gave special attention, but in a larger way he made a general study of the universe, and in a series of treatises undertook to reveal the whole field of science. But his work simply became a vast commentary on the account of creation given in the book of Genesis. Beginning with the work of the Trinity at the creation, he goes on to detail the work of angels in all their fields, and makes

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* For a very careful discussion of Albert's strength in investigation and weakness in yielding to scholastic authority, see Kopp, Ansichten über die Aufgabe der Chemie von Geber bis Stahl, Braunschweig, 1875, pp. 64 *et seq.* For a very extended and enthusiastic biographical sketch, see Pouchet. For comparison of his work with that of Thomas Aquinas, see Milman, History of Latin Christianity, vol. vi, p. 461. "Il était aussi très-habile dans les arts mécaniques, ce que le fit soupçonner d'être sorcier" (Sprengel, Histoire de la Médecine, vol. ii, p. 389). For Albert's biography treated strictly in accordance with ecclesiastical methods, see Albert the Great, by Joachim Sighart, translated by the Rev. T. A. Dickson, of the Order of Preachers, published under the sanction of the Dominican censor and of the Cardinal Archbishop of Westminster, London, 1876. How an Englishman like Cardinal Manning could tolerate among Englishmen such an unctuous glossing over of historical truth is one of the wonders of contemporary history. For choice specimens see chapters ii and iv. For one of the best and most recent summaries, see Heller, Geschichte der Physik, Stuttgart, 1882, vol. i, pp. 179 *et seq.*

excursions into every part of creation, visible and invisible, but always with the most complete subordination of his thought to the literal statements of Scripture.

Could he have taken the path of experimental research, the world would have been enriched with most precious discoveries; but the force which had given wrong direction to Albert of Bollstadt, backed as it was by the whole ecclesiastical power of his time, was too strong, and in all the life labor of Vincent nothing appears of any permanent value. He reared a structure which the adaptation of facts to literal interpretations of Scripture, and the application of theological subtleties to Nature combine to make one of the most striking monuments of human error.*

But the theological spirit of the thirteenth century gained its greatest victory in the work of St. Thomas Aquinas. In him was the theological spirit of his age incarnate. Although he yielded somewhat at one period to love of natural science, it was he who finally made that great treaty or compromise which for ages subjected science entirely to theology. He it was who reared the most enduring barrier against those who in that age and in succeeding ages labored to open for science the path by its own legitimate methods toward its own noble ends.

He had been the pupil of Albert the Great, and had gained much from him. Through the earlier systems of philosophy, as they were then known, and through the earlier theologic thought, he had gone with great labor and vigor; and all his mighty powers, thus disciplined and cultured, he brought to bear in making a treaty or truce which was to give theology permanent supremacy over science.

The experimental method had already been practically initiated; Albert of Bollstadt and Roger Bacon had begun their work in accordance with its methods; but St. Thomas gave all his thoughts to bringing science again under the sway of theological methods and ecclesiastical control. In his commentary on Aristotle's treatise upon Heaven and Earth, he gave to the world a striking example of what his method could produce; illustrating all the evils which arise in combining theological reasoning and literal interpretation of Scripture with scientific facts, and this work remains to this day a monument of scientific genius perverted by theology.†

The ecclesiastical power of the time hailed him as a deliverer; it was claimed that miracles were vouchsafed, proving that the

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* For Vincent de Beauvais, see Études sur Vincent de Beauvais, par l'Abbé Bourgeat, chaps. xii, xiii, and xiv; also Pouchet, Histoire des Sciences Naturelles au Moyen Age, Paris, 1853, pp. 470 *et seq.*; also other histories cited hereafter.

† For citations showing this subordination of science to theology, see Eicken, chap. vi.

blessing of Heaven rested upon his labors; and among the legends embodying this claim is that given by the Bollandists and immortalized by a renowned painter. The great philosopher and saint is represented in the habit of his order, with book and pen in hand, kneeling before the image of Christ crucified, and as he kneels the image thus addresses him: "Thomas, thou hast written well concerning me; what price wilt thou receive for thy labor?" The myth-making faculty of the people at large was also brought into play. According to a wide-spread and circumstantial legend, Albert, by magical means, created an android—an artificial man, living, speaking, and answering all questions with such subtlety that St. Thomas, unable to answer its reasoning, broke it to pieces with his staff.

To this day historians of the Roman Church like Rohrbacher, and historians of science like Pouchet, find it convenient to propitiate the Church by dilating upon the glories of St. Thomas Aquinas in thus making an alliance between religious and scientific thought, and laying the foundations for a "sanctified science"; but the unprejudiced historian can not indulge in this enthusiastic view: the results both for the Church and for science have been most unfortunate. It was a wretched delay in the evolution of fruitful thought; for the first result of this great man's great compromise was to close for ages that path in science which above all others leads to discoveries of value—the experimental method—and to reopen that old path of mixed theology and science which, as Hallam declares, "after three or four hundred years had not untied a single knot or added one unequivocal truth to the domain of philosophy"—the path which, as all modern history proves, has ever since led only to delusion and evil.*

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* For the work of Aquinas, see his Liber de Cœlo et Mundo, section xx; also, Life and Labors of St. Thomas of Aquin, by Archbishop Vaughan, pp. 459 *et seq.* For his labors in natural science, see Hoefer, Histoire de la Chimie, Paris, 1843, vol. i, p. 381. For theological views of science in the middle ages, and rejoicing thereat, see Pouchet, Hist. des Sci. Nat. au Moyen Age, *ubi supra*. Pouchet says: "En général au milieu du moyen âge les sciences sont essentiellement chrétiennes, leur but est tout-à-fait religieux, et elles semblent beaucoup moins s'inquiéter de l'avancement intellectuel de l'homme que de son salut eternel." Pouchet calls this "conciliation" into a "harmonieux ensemble" "la plus glorieuse des conquêtes intellectuelles du moyen âge." Pouchet belongs to Rouen, and the shadow of Rouen Cathedral seems thrown over all his history. See, also, l'Abbé Rohrbacher, Hist. de l'Église Catholique, Paris, 1858, vol. xviii, pp. 421 *et seq.* The abbé dilates upon the fact that "the Church organizes the agreement of all the sciences by the labors of St. Thomas of Aquin and his contemporaries." For the complete subordination of science to theology by St. Thomas, see Eicken, chap. vi. For the theological character of science in the middle ages, recognized by a Protestant philosophic historian, see the well-known passage in Guizot, History of Civilization in Europe; and by a noted Protestant ecclesiastic, see Bishop Hampden's Life of Thomas Aquinas, chaps. xxxvi, xxxvii; see also Hallam, Middle Ages, chap. ix. For dealings of Pope John XXII, of the Kings of France and England, and of the Republic of Venice, see Figuier, L'Alchimie et les Alchimistes, pp. 140, 141, where, in a note,

The theological path thus opened by these strong men became the main path for science during ages, and it led the world ever further and further from any fruitful fact or useful method. Roger Bacon's investigations already begun were discredited; worthless mixtures of scriptural legends with imperfectly authenticated physical facts took their place. Thus it was that for twelve hundred years the minds in control of Europe regarded all real science as *futile*, and diverted the great current of earnest thought into theology.

The next stage in this evolution was the development of an idea which acted with great force throughout the middle ages —the idea that science is *dangerous*. As we have seen in other chapters, there was evolved more and more a vivid sense of the interference of Satan with human affairs, and especially of the interference of the ancient gods whom St. Paul had explicitly declared to be devils, and who were naturally indignant at their dethronement. More and more suspicion attached to all men who attempted anything in the development of science. The old scriptural warrrant for the existence of sorcery and magic was brought in as a powerful argument against such men. The conscience of the time, therefore, acting in obedience to the highest authorities in the Church, and, as was supposed, in defense of religion, brought out a missile which it hurled against scientific investigators with deadly effect; the mediæval battlefields of thought were strewn with such; it was the charge of sorcery and magic—of unlawful compact with the devil. This missile was effective. We find it used against every great investigator of Nature in those times and for ages after. The list of great men in those centuries charged with magic, as given by Naudé, is astounding; it includes every man of real mark, and in the midst of them stands one of the most thoughtful popes, Sylvester II (Gerbert), and the foremost of mediæval thinkers on natural science, Albert the Great. It came to be the accepted idea that as soon as a man conceived a wish to study the works of God his first step must be a league with the devil.*

The first great thinker who, in spite of some stumbling into theologic pitfalls, persevered in a truly scientific path, was Roger Bacon. His life and works seem until recently to have been generally misunderstood: he was formerly ranked as a superstitious

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the text of the bull *Spondent Pariter* is given. For popular legends regarding Albert and St. Thomas, see Elephas Levi, Hist. de la Magie, chap. v.

* For the charge of magic against scholars and others, see Naudé, Apologie pour les grands hommes soupçonnés de Magie, *passim*; also, Maury, Hist. de la Magie, troisième édit., pp. 214, 215; also, Cuvier, Hist. des Sciences Naturelles, vol. i, p. 396. For a circumstantial account of this charge of magic against Pope Boniface VIII, see Milman, Latin Christianity, Book XII, chap. iii.

alchemist who happened upon some inventions, but more recent investigation has shown him to be one of the great masters in the evolution of human thought. The advance of sound historical judgment seems likely to bring the fame of the two who bear the name of Bacon nearer to equality. Bacon of the chancellorship and of the Novum Organum may not wane, but Bacon of the prison-cell and the Opus Major steadily approaches him in brightness.

More than three centuries before Francis Bacon advocated the experimental method, Roger Bacon practiced it, and the results as now revealed are wonderful. He wrought with power in many sciences, and his knowledge was sound and exact. By him, more than by any other man of the middle ages, was the world brought into the more fruitful paths of scientific thought—the paths which have led to the most precious inventions; and among these are clocks, lenses, burning specula, telescopes, which were given by him to the world, directly or indirectly. In his writings are found formulæ for extracting phosphorus, manganese, and bismuth. It is even claimed, with much appearance of justice, that he investigated the power of steam, and he seems to have very nearly reached some of the principal doctrines of modern chemistry. But it should be borne in mind that his *method* of investigation was even greater than its *results*. In an age when theological subtilizing was alone thought to give the title of scholar, he insisted on *real* reasoning and the aid of natural science by mathematics; in an age when experimenting was sure to cost a man his reputation, and was likely to cost him his life, he insisted on experimenting, and braved all its risks. Few greater men have lived. As we read the sketch given by Whewell of Bacon's process of reasoning regarding the refraction of light, he seems divinely inspired.

On this man came the brunt of the battle. The most conscientious men of his time thought it their duty to fight him, and they fought him steadily and bitterly. His sin was not disbelief in Christianity, not want of fidelity to the Church, not even dissent from the main lines of orthodoxy; on the contrary, he showed in all his writings a desire to strengthen Christianity, to build up the Church, and to develop orthodoxy. He was attacked and condemned mainly because he did not believe that philosophy had become complete, and that nothing more was to be learned; he was condemned, as his opponents expressly declared, "on account of certain suspicious novelties"—"*propter quasdam novitates suspectas.*"

Upon his return to Oxford, about 1250, the forces of unreason beset him on all sides. Greatest of all his enemies was Bonaventura. This enemy was the theologic idol of the period: the

learned world knew him as the "seraphic Doctor"; Dante gave him an honored place in the great poem of the middle ages; the Church finally enrolled him among the saints. By force of great ability in theology he had become in the middle of the thirteenth century general of the Franciscan order; thus, as Bacon's master, his hands were laid heavily on the new teaching, so that in 1257 the troublesome monk was forbidden to lecture; all men were solemnly warned not to listen to his teaching, and he was ordered to Paris, to be kept under surveillance by the monastic authorities. Herein was exhibited another of the myriad examples showing the care exercised over scientific teaching by the Church. The reasons for thus dealing with Bacon were evident: First, he had dared attempt scientific explanations of natural phenomena, which, under the mystic theology of the middle ages, had been referred simply to supernatural causes. Typical was his explanation of the causes and character of the rainbow. It was clear, cogent, a great step in the right direction as regards physical science: but there, in the book of Genesis, stood the time-honored legend regarding the origin of the rainbow, supposed to have been dictated immediately by the Holy Spirit; and, according to that, the "bow in the cloud" was not the result of natural laws, but a "sign" arbitrarily placed in the heavens for the simple purpose of assuring mankind that there should not be another universal deluge.

But this was not the worst: another theological idea was arrayed against him,—the idea of satanic intervention in science; hence he was attacked with that goodly missile which with the epithets "infidel" and "atheist" has decided the fate of so many battles—the charge of magic and compact with Satan.

He defended himself with a most unfortunate weapon—a weapon which exploded in his hands and injured him more than the enemy. For he argued against the idea of compacts with Satan, and showed that much which is ascribed to demons results from natural means. This added fuel to the flame; to limit the power of Satan was deemed hardly less impious than to limit the power of God.

The most powerful protectors availed him little. His friend Guy Foulkes, having in 1265 been made pope under the name of Clement IV, shielded Bacon for a time; but the fury of the enemy was too strong, and when he made ready to perform a few experiments before a small audience, we are told that all Oxford was in an uproar. It was believed that Satan was about to be let loose. Everywhere priests, monks, fellows, and students rushed about, their garments streaming in the wind, and everywhere rose the cry, "Down with the magician!" and this cry, "Down with the magician!" resounded from cell to cell, and from hall to hall.

Another weapon was also used upon the battle-fields of science in that time with much effect. The Arabs had made many noble discoveries in science, and Averroes had, in the opinion of many, divided the honors with St. Thomas Aquinas; these facts gave the new missile—it was the epithet "Mohammedan"—this too was flung with effect at Bacon.

The attack now began to take its final shape. The two great religious orders, Franciscan and Dominican, then in all the vigor of their youth, vied with each other in fighting the new thought in chemistry and physics. St. Dominic solemnly condemned research by experiment and observation; the general of the Franciscan order took similar ground. In 1243 the Dominicans interdicted every member of their order from the study of medicine and natural philosophy, and in 1287 this interdiction was extended to the study of chemistry.

In 1278 the authorities of the Franciscan order, assembled at Paris, solemnly condemned Bacon's teaching, and the general of the Franciscans, Jerome d'Ascoli, afterward Pope, threw him into prison, where he remained for fourteen years. Though Pope Clement VI had protected him, Popes Nicholas III and IV, by virtue of their infallibility, decided that he was too dangerous to be at large, and he was only released at the age of eighty, but a year or two before death placed him beyond the reach of his enemies. How deeply the struggle had racked his mind may be gathered from that last affecting declaration of his, "Would that I had not given myself so much trouble for the love of science!"

The attempt has been made by sundry champions of the Church to show that some of Bacon's utterances against ecclesiastical and other corruptions in his time were the main cause of the severity which the Church authorities exercised against him. This helps the Church but little, even if it be well based, but it is not well based. That some of his utterances of this sort made him enemies is doubtless true, but the charges on which St. Bonaventura silenced him, and Jerome of Ascoli imprisoned him, and successive popes kept him in prison for fourteen years, were "dangerous novelties" and suspected sorcery.

Sad is it to think of what this great man might have given to the world had ecclesiasticism allowed the gift. He held the key of treasures which would have freed mankind from ages of error and misery. With his discoveries as a basis, with his method as a guide, what might not the world have gained! Nor was the wrong done to that age alone; it was done to this age also. The nineteenth century was robbed at the same time with the thirteenth. But for that interference with science the nineteenth century would be enjoying discoveries which will not be reached

before the twentieth century. Thousands of precious lives shall be lost in this century, tens of thousands shall suffer discomfort, privation, sickness, poverty, ignorance, for lack of discoveries and methods which, but for this mistaken dealing with Roger Bacon and his compeers, would now be blessing the earth.

In two recent years sixty thousand children died in England and in Wales of scarlet fever; probably quite as many died in the United States. Had not Bacon been hindered, we should have had in our hands, by this time, the means to save two thirds of these victims; and the same is true of typhoid, typhus, cholera, and that great class of diseases of whose physical causes science is just beginning to get an inkling. Put together all the efforts of all the atheists who have ever lived, and they have not done so much harm to Christianity and the world as has been done by the narrow-minded, conscientious men who persecuted Roger Bacon, and closed the path which he gave his life to open.

But despite the persecution of Bacon and the defection of those who ought to have followed him, champions of the experimental method rose from time to time during the succeeding centuries. We know little of them personally; our main knowledge of their efforts is derived from the endeavors of their persecutors.

In 1317 Pope John XXII issued his bull, *Spondent pariter*, leveled at the alchemists, but really dealing a terrible blow at the beginnings of chemical science. That many alchemists were knavish is no doubt true, but no infallibility in separating the evil from the good was shown by the papacy in this matter. In this and in sundry other bulls and briefs we find Pope John, by virtue of his infallibility as the world's instructor in all that pertains to faith and morals, condemning real science and pseudo-science alike. In two of these documents, supposed to be inspired by wisdom from on high, he complains that both he and his flock are in danger of their lives by the arts of sorcerers; he declares that such sorcerers can send devils into mirrors and finger-rings, and kill men and women by a magic word; that they had tried to kill him by piercing his waxen image with needles, in the name of the devil. He, therefore, called on all rulers, secular and ecclesiastical, to hunt down the miscreants who thus afflicted the faithful, and he especially increased the powers of inquisitors in various parts of Europe for this purpose.

The impulse thus given to childish fear and hatred against the investigation of Nature was felt for centuries. More and more chemistry came to be known as one of the "seven devilish arts."

These declarations of Pope John were echoed for generation after generation, until nearly three hundred years later there came the yet more terrible bull of Pope Innocent VIII, known as *Summis Desiderantes*, which let inquisitors loose upon Germany,

and armed them with the *malleus maleficarum*, to torture and destroy men and women by tens of thousands for sorcery and magic.

Under such guidance the secular rulers were naturally vigorous in the same policy. In 1380 Charles V of France forbade the possession of furnaces and apparatus necessary for chemical processes. Under this law the chemist John Barrillon was thrown into prison, and it was only by the greatest effort that his life was saved. In 1404 Henry IV of England issued a similar decree, and in 1418 the Republic of Venice followed these examples.

But champions of science still pressed on. The judicial torture and murder of Antonio de Dominis were not simply for heresy; his investigations in the phenomena of light were an additional crime. Pierre de la Ramée fell in the massacre of St. Bartholomew as a heretic, but his teachings had previously been stopped by a royal edict, sought by the Church on account of his breaking away from the old theological methods.*

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* For an account of Bacon's treatise, De Nullitate Magiæ, see Hoefer. For the uproar caused by Bacon's teaching at Oxford, see Kopp, Geschichte der Chemie, Braunschweig, 1343, vol. i, p. 63; and for a somewhat reactionary discussion of Bacon's relation to the progress of chemistry, see a recent work by the same author, Ansichten über die Aufgabe der Chemie, Braunschweig, 1874, pp. 85 *et seq.*; also, for an excellent summary, see Hoefer, Hist. de la Chimie, vol. i, pp. 368 *et seq.* For probably the most thorough study of Bacon's general works in science, and for his views of the universe, see Prof. Werner, Die Kosmologie und allgemeine Naturlehre des Roger Baco, Wien, 1879. For summaries of his work in other fields, see Whewell, vol. i, pp. 367, 368; Draper, p. 438; Saisset, Descartes et ses Précurseurs, deuxième édition, pp. 397 *et seq.*; Nourrisson, Progrès de la Pensée humaine, pp. 271, 272; Sprengel, Histoire de la Médecine, Paris, 1865, vol. ii, p. 397; Cuvier, Histoire des Sciences Naturelles, vol. i, p. 417. As to Bacon's orthodoxy, see Saisset, pp. 53, 55. For special examination of causes of Bacon's condemnation, see Waddington, cited by Saisset, p. 14. On Bacon as a sorcerer, see Featherstonhaugh's article in North American Review. For a brief but admirable statement of Roger Bacon's relation to the world in his time, and of what he might have done had he not been thwarted by theology, see Döllinger, Studies in European History, English translation, London, 1890, pp. 178, 179. For a good example of the danger of denying the full power of Satan, even in much more recent times and in a Protestant country, see account of treatment of Bekker's Monde Enchanté by the theologians of Holland, in Nisard, Histoire des Livres Populaires, vol. i, pp. 172, 173. Kopp, in his Ansichten, pushes criticism even to some skepticism as to Roger Bacon being the *discoverer* of many of the things generally attributed to him; but, after all deductions are carefully made, enough remains to make Bacon the greatest benefactor to humanity during the middle ages. For Roger Bacon's deep devotion to religion and the Church, see citation and remarks in Schneider, Roger Bacon, Augsburg, 1873, p. 112; also, citation from the Opus Majus in Eicken, chap. vi. On Bacon as a "Mohammedan," see Saisset, p. 17. For the interdiction of studies in physical science by the Dominicans and Franciscans, see Henri Martin, Histoire de France, vol. iv, p. 283. For the suppression of chemical teaching by the Parliament of Paris, see Henri Martin, Histoire de France, vol. xii, pp. 14, 15. For proofs that the world is steadily working toward great discoveries as to the cause and prevention of zymotic diseases and of their propagation, see Beale's Disease Germs, Baldwin Latham's Sanitary Engineering, Michel Lévy's Traité d'Hygiène Publique et Privée. For a summary of the bull *Spondent pariter*, and for an example of injury done by it, see

To question the theological view of physical science was, even long after the close of the middle ages, exceedingly perilous. We have seen in this chapter how one of Roger Bacon's unpardonable offenses was his argument against the efficacy of magic, and in chapters preceding how centuries afterward Wyer, Flade, Bekker, and a multitude of other investigators and thinkers suffered confiscation of property, loss of position, and even torture and death, for similar views. I will refer, then, to but one more case as typical.

In the last year of the sixteenth century the persecutions for witchcraft and magic were especially cruel in the western districts of Germany, the main instrument in them being Binsfeld, Suffragan Bishop of Treves.

At that time Cornelius Loos was a professor at the university of that city. He was a devoted churchman, and one of the most brilliant opponents of Protestantism, but he finally saw through the prevailing belief regarding occult powers, and in an evil hour for himself embodied his idea in a book entitled "True and False Magic." The book, though earnest, was temperate, but this helped him and his cause not at all. The texts of Scripture clearly sanctioning belief in sorcery and magic stood against him, and these had been confirmed by the infallible teachings of the Church and the popes from time immemorial; the book was stopped in the press, the manuscript confiscated, and Loos thrown into a dungeon.

The inquisitors having wrought their will upon him, in the spring of 1593 he was brought out of prison, forced to recant on his knees before the assembled dignitaries of the Church, and thenceforward kept constantly under surveillance, and at times in prison. Even this was considered too light a punishment, and his arch-enemy, the Jesuit Del Rio, declared that but for his death by plague he would have been finally sent to the stake. His manuscript, hidden away in the archives at Treves, was supposed to be lost until within the present decade. After three centuries what remains of it has been brought to light by an American scholar.*

Schneider, Geschichte der Alchemie, p. 160; and for a studiously moderate statement, Milman, Latin Christianity, Book XII, chap. vi. For character and general efforts of John XXII, see Lea, Inquisition, iii, 436, also 452 *et seq.* For the character of the two papal briefs, see Rydberg, p. 177. For the Bull *Summis Desiderantes*, see previous chapters of this work. For Antonio de Dominis, see Montucla, Hist. des Mathématiques, vol. i, p. 705, Humboldt, Cosmos, Libri, vol. iv, pp. 145 *et seq.*

* Prof. George Lincoln Burr, of Cornell University, whose copy of Loos's MS. is now in the library of that institution. For a full account of the discovery and its significance, see the New York Evening Post for November 13, 1886. The facts regarding the after-life of Loos, were discovered by Prof. Burr in the archives at Brussels. For Weyer, Flade, Bekker, and others, see the chapters of this work on Demoniacal Possession and Insanity, and Diabolism and Hysteria.

MODERN INSTANCES OF DEMONIACAL POSSESSION.

By Prof. E. P. EVANS.

PERHAPS few persons are fully aware of the official attitude of the Papal See toward beliefs which modern science has rejected as absurd, and toward institutions which the progress of civilization has abolished as injurious. In a recent review of Cesare Cantù's voluminous Universal History, the Jesuit Father Giuseppe Brunengo criticises this popular work from a Catholic point of view, and censures its deviations from the teachings of the Church.*

Cantù, now in the eighty-eighth year of his age, is himself a devout Catholic, and scrupulously abstained from reading any books condemned by the Congregation of the Index, however necessary they might be to his historical researches, until he had obtained permission from the Pope. He also submitted his History to the scrutiny of the aforesaid Congregation, and declared his willingness to expunge any passages that should not be regarded as strictly orthodox. Indeed, he performed this unpleasant and onerous task in 1867, and again in 1886, and won thereby the warm commendation of Leo XIII, formally expressed in an apostolical brief dated June 3, 1886. But the Holy Office, more papal than the Pope, was not satisfied with the expurgations that had been so gratifying to his Holiness.

In a series of articles first printed in the Civiltà Cattolica, and now republished in a separate volume, Brunengo re-examines Cantù's work, and, while praising in general the "Christian and catholic spirit" which pervades it, points out many statements and conclusions at variance with the doctrines of the Church. In the first place, he seems to think that no Catholic historian should record anything derogatory to the character of any pope; at least, he blames Cantù for not speaking well of Sergius III, John X, and John XI, notoriously licentious pontiffs of the tenth century, whose rule is known in ecclesiastical history as the pornocracy, and reproves him for not emphasizing the wickedness of Savonarola in opposing Alexander VI. On the other hand, no Catholic historian should praise a Protestant or a heretic; and in accordance with this principle Cantù is severely reprehended for admitting that Calvin was a man of pure morals and improved by his teaching and example the morals of the Swiss; that Scipio Ricci, Bishop of Pistoia, was "pious and learned"; that the Jansenists were not wholly devoid of good qualities; and that Döllinger was

* Osservazioni sopra la storia universale di Cesare Cantù del P. Giuseppe Brunengo, D. C. D. G. Rome, 1891, pp. 150.

erudite and virtuous. Such concessions are marks of mental obtuseness or moral weakness, and ought never to be made.

Again, Cantù is censured for questioning the strictly historical character of hagiological narrations, and for assuming that many of the stories told of St. George, John of Neponuk, Hermenigilda, and other canonized persons, are mere legends; also for animadverting on some of the actions attributed to the saints as unworthy of holy men.

Cantù maintains that the Spanish, unlike the Roman Inquisition, was an institution not of the Church but of the state, and therefore feels himself more at liberty in describing and condemning its proceedings. Brunengo declares this view to be wholly untenable, and proves conclusively that the Inquisition in Spain was not a political but an ecclesiastical tribunal, created and conducted by the apostolical authority of the Pope in the interests of the Roman hierarchy.

Having settled this point, he asserts, in opposition to Cantù, that the Inquisition was an immense boon to Spain, and that whatever material loss may have been incurred by the expulsion of the Moors and other skillful and thrifty artisans was more than made good to the nation by the great treasure of religious unity which the Holy Office secured.

So, too, the right of the Pope to depose sovereigns and to absolve their subjects from allegiance rests upon the supreme and universal dominion conferred by Christ upon his vicar, and can not be changed by circumstances nor abrogated by human enactments. The same holds true of the temporal sovereignty of the Pope, which ungodly revolutions and sacrilegious usurpations may put temporarily in abeyance, but can never annul and permanently abolish.

Still more antagonistic to the enlightened spirit of the age is Brunengo's defense of the reality of witchcraft and diabolical possession as dogmas of the Catholic Church. He sharply rebukes Cantù for treating this belief as an "error," and adds: "There are one hundred and three papal bulls which served inquisitors as a rule of procedure in prosecutions for witchcraft, magic, and other sorceries. If the Popes, who published these edicts, had doubted even for a moment the truth and reality of the enormities ascribed to magic; if they had believed with Cantù or entertained the slightest suspicion that the belief in a direct intercourse of the devil with man is a mere fancy or illusion, they would have expressed themselves very differently in those bulls, and endeavored to explain to the faithful the vanity and inanity of all magic arts. But because they had no doubt of the reality of these things they used an entirely different language. Now, whom are we to believe—Cantù, who absolutely contests the actu-

ality of witchcraft; or the popes, bishops, and synods that have unanimously, with the necessary limitations, established it as a Catholic doctrine?"

There are doubtless many sincere Catholics, like Cantù, who repudiate the belief in demoniacal possession, but Brunengo is unquestionably right in affirming that this view is opposed to the plain teaching and actual practice of the Church on this subject. Leo XIII is justly regarded as a man of more than ordinary intelligence, and, more thoroughly imbued with the modern spirit than any of his predecessors, yet he composed and issued, November 19, 1890, a formula of *Exorcismus in Satanam et Angelos Apostatas* worthy of a place in any mediæval collection of conjurations. His Holiness never fails to repeat this exorcism in his daily prayers, and commends it to the bishops and other clergy as a potent means of warding off the attacks of Satan and of casting out devils. In 1849 the Bishop of Passau published a Manuale Benedictionum for the same purpose; and in 1851 there was printed at Munich, in Bavaria, a work entitled Rituale Ecclesiasticum ad usum clericorum ordinis S. Francisci, by Pater Franz Xaver Lohbauer, in which the theory of demoniacal possession is maintained, and the method to be pursued in such cases minutely prescribed—*Modus jurandi afflictos a dæmone.* The author of this ritual distinctly declares that nearly all so-called nervous diseases, hysteria, epilepsy, insanity, and milder forms of mental alienation, are either the direct result of diabolical agencies or attended and greatly aggravated by them. A sound mind in a sound body may make a man devil-proof, but Satan is quick to take advantage of the infirmities of men in order to get possession of their persons. The adversary is constantly lying in wait watching for and trying to produce physical derangements as breaches in the wall, through which he may rush in and capture the citadel of the soul. In all cases of this sort the priest is to be called in with the physician, and the medicines are to be blessed and sprinkled with holy water before being administered. Exorcisms and conjurations are not only to be spoken over the patient, but also to be written on slips of consecrated paper and applied, like a plaster, to the parts especially affected. The physician should keep himself supplied with these written exorcisms, to be used when it is impossible for a priest to be present. As with patent medicines, the public is warned against counterfeits, and no exorcism is genuine unless it is stamped with the seal of the bishop of the diocese. According to Father Lohbauer, the demon is the efficient cause of the malady, and there can be no cure until the evil one is cast out. This is the office of the priest; the physician then heals the physical disorder, repairing the damage done to the body, and, as it were, stopping the gaps with his drugs so as to prevent the demon from getting

in again. Here we have an example of the reconciliation and harmonious co-operation of religion and science, which so many earnest thinkers of to-day are rather futilely striving after.

The latest expression of the views of the Catholic Church on demoniacal possession is contained in a pamphlet just printed at Munich, in which the casting out of a devil in Wernding is fully and officially reported by the exorcist himself, Father Aurelian, and the case "critically elucidated for the people" by Richard Treufels. (Die Teufelsaustreibung in Wernding. Nach dem Berichte des P. Aurelian für das Volk kritisch beleuchtet von Richard Treufels. München: Schuh & Cie., 1892. Pp. 14. Treufels is doubtless a pseudonym chosen by the author to indicate that his feet are planted on the rock of faith.)

The report itself is substantially as follows: On Shrove Tuesday, February 10, 1891, a boy, ten years of age, named Michael Zilk, the eldest son of a miller living near Wernding, in Bavaria, began to act in a very strange manner. He could not say his prayers nor hear another person pray without falling into fits of rage. The same effect was produced by the sight of a crucifix or of holy water, and by passing near a sacred shrine or a church. A physician was consulted, but without avail; equally ineffective were the benedictions pronounced by Parson Seitz, of Dürrwangen; finally, recourse was had to the capuchins of Wernding, where Father Aurelian took the case in hand, and, after a long process of spiritual or magical diagnosis, consisting in the utterance of various forms of benediction and incantation, declared that all the symptoms indicated demoniacal possession. This opinion was indorsed by the Right Reverend Bishop Pancratius, of Augsburg, who saw the boy May 12, 1891, and, "in the full consciousness of his episcopal power and dignity," called upon the unclean spirit to come out of him, but the obstinate imp refused to obey. At length, after special permission was obtained from Bishop Leopold, of Eichstadt, to whose diocese Wernding belongs, the ceremony of exorcism was solemnly performed.

We need not here enter into a detailed description of the hocus-pocus, which began on the morning of July 13th, and ended with the expulsion of the demon or demons (for there seem to have been ten of them) on the evening of the next day. So great was the strength imparted to the boy by the indwelling devils that half a dozen men could hardly carry him into the presbytery of the cloister church, where the conjuration was to be performed in the presence of the parents and a few friars and devout laymen. The results, however, were wholly unsatisfactory, and in the afternoon the scene of the ceremony was transferred to the choir of the church; but even then no response was elicited, until Father Aurelian threatened to bring in the monstrance and compel the

demon to worship it. This was more than the devil could stand, and he cried out in a terrible rage, "The boy is possessed!" The good monk lays peculiar stress upon this incident, as furnishing conclusive proof of the real presence of Christ in the holy sacrament. Further interrogatories brought out the fact already mentioned, that the demons were ten in number, although the answers were always given in the first person singular and in the Bavarian dialect. Thus, when conjured to go out of the boy, the demon replied, "I mog net" (*Ich mag nicht;* I don't want to).

Father Aurelian, having now got the devil so far under control as to make him speak, felt sure of a brilliant success, and on the morning of July 14th threw the church open to the public. Wernding, it must be remembered, has not only a sulphur-bath for the periodical purging of the profane, but also a wonder-working shrine, to which thousands of pious pilgrims resort in order to be purified from sin. On this occasion the persons who filled the church were chiefly penitents of the latter class, and constituted a fit audience of eager and credulous witnesses fully in sympathy with Father Aurelian and the marvelous work he had undertaken to perform, howling, moaning, and praying, and wringing their hands as the priest went on with his exorcisms.

The following is the substance of the dialogue between the capuchin and the devil:

C. You must depart from the child; there is no help for you.

D. I can't.

C. Why can't you?

D. Because she is always banning.

C. Who is banning? Some woman?

D. Yes.

C. What is her name?

D. Herz.

On hearing this, the parents lifted up their arms and exclaimed, "She is our neighbor!"

C. Why did she send you into the child?

D. Because she was angry.

C. Had the child done her any harm?

D. No.

C. How long have you possessed the child?

D. Six months.

C. When are you going to get out?

D. I don't know.

C. Why don't you know?

D. Because this woman Herz keeps on banning, and so long as she does this I can't go.

This conversation, repeated again and again with slight variations, occupied the whole forenoon.

When the exorcism was resumed at one o'clock in the afternoon, the devil was evidently considerably dispirited; occasionally he roused himself and "tore" the boy, but less violently than before, and no longer showed his spite by spitting at the priest. After having gone through with the usual forms of conjuration with the cross, and having brought the magic power of the Host to bear upon the stubborn imp, the capuchin called upon him in the name of God, and the mother of God, and the holy archangel Michael, to say whether he would now depart, and received the answer uttered in a humble tone, "Yes." This question was repeated three times, with the same result. "The first time," says Father Aurelian, "that the devil expressed his willingness to go out of the boy, I conjured him not to enter into any of the persons present nor into any living creature, not even into the woman Herz, who had banned him into the boy, but to depart to the place which God had assigned him. After a short pause I put the question, 'Have you departed from the boy?' and received the answer, 'Yes.' 'And also your companions?' 'Yes.' 'For the third time I conjure you to tell the whole truth: have you and your companions departed from the boy?' 'Yes.' 'Where are you now?' 'In hell.' 'And your companions, too?' 'Yes.' 'In the name of the most holy Trinity, and this sign of the cross, I conjure you to confess whether you and your companions are really in hell!' 'Yes, we are in hell!' was the horrifying reply. And it really seemed as though the voice came from hell. In his former answers the demon had spoken in a sharp and insolent tone, but this last response was utterly subdued and extremely mournful."

Michael Zilk, thus freed from the unclean spirit, quietly kneeled before the altar, kissed the crucifix, partook of the holy sacrament, and devoutly repeated the *Pater noster* and *Ave Maria*. A *Te Deum* was sung at the high altar, and on the following morning a special service of thanksgiving, consisting of high mass with rosary, was held in recognition of the "mighty work" that had been so successfully accomplished.

To Father Aurelian's mind, such as it is, the cause of the demoniacal possession is perfectly clear, and he states his views without reserve. The father of the boy, he says, was a Catholic, and the mother a Protestant; they were married by a Protestant clergyman, and the children were educated in the Protestant faith. The father afterward repented of his grievous fault, and endeavored to repair it by sending his three children to a Catholic school. This step excited the anger of his Protestant neighbors, one of whom, a woman named Herz, took to cursing and banning, and sent the devil into the eldest child by giving him on Shrove Tuesday a quantity of dried pears (*Hutzeln*) to eat,

over which the witch had doubtless muttered wicked spells. Fifty dried pears—and this is the number the boy is said to have eaten—one would think, might suffice to play the devil with his stomach, without supernatural aid or intervention. It is the old story: If the child suffers from a surfeit of sweetmeats, it is not the goodies, but the goody, who is at the bottom of it, and who must have sprinkled her gift with devil's powder in saccharine disguise, or manufactured the sugar-plums at midnight out of witches' butter.

We are further informed that the father, after frequent conferences with the capuchins, has made good his unfortunate marriage: the nuptial ceremony has been performed again according to the Catholic ritual, and the children have been rebaptized by a Catholic priest. The mother, too, has been persuaded to join the Catholic communion, or rather driven into the fold by the persecutions of a violently bigoted mother-in-law, who was evidently the real demon of the household.

A "mixed marriage," although recognized as legitimate by the law of the land, has never been regarded by the Church as just and valid, but is characterized in ecclesiastical legal terminology as *matrimonium legitimum sed non ratum.* It has been reserved, however, for Father Aurelian to discover that the offspring of such unions easily come under the influence of evil spirits, and are peculiarly liable to demoniacal possession.

As convincing proof of diabolic agency, the exorcist makes the following assertion: "When I sprinkled the possessed boy with holy water, he sprang toward me in rage; if I used ordinary water, he kept perfectly quiet. In like manner, when I uttered a prayer of the Church in Latin, he became furious; if I repeated a passage from a Latin classic, he remained perfectly calm." Besprinklings with the foul contents of an *aspercorium* might excite the wrath of even a gentler spirit than a goblin from Tartarus; and although it may be true, as a popular proverb asserts, that "the devil is an ass," he would also seem to be a good Latinist (a union of the twain is not so rare a phenomenon as the unlearned are apt to suppose), and a sensitive purist quick to detect and to resent any forms of expression less correct and elegant than strictly classical locutions. Unfortunately, however, for Father Aurelian's argument, another priest who examined the boy positively denies this statement, and declares that, when Michael Zilk was sprinkled with holy water secretly from behind, the indwelling devil gave no sign. In concluding his report, Father Aurelian uses the following strong language: "Whoever denies demoniacal possession in our days, confesses thereby that he has gone astray from the teaching of the Catholic Church; but he will believe in it when he himself is in the

possession of the devil in hell. As for myself, I have the authority of two bishops."

It was formerly held by both Catholics and Protestants that unbaptized children were in the power of the devil, and the Catholic ritual still prescribes the following formula of exorcism, to be used before baptism: "I exorcise thee, unclean spirit, in the name of the Father, and the Son, and the Holy Ghost, that thou departest and goest forth from this servant of God; for he who walked on the sea, and extended his right hand to the sinking Peter, commands thee, O damned one! Therefore, accursed devil, know thy doom, and give honor to the living and true God, give honor to Jesus Christ and to the Holy Ghost, and go out of this servant of God, whom God and our Lord Jesus Christ have deigned to call by his grace and mercy to the fountain of baptism. [Here the priest makes the sign of the cross on the child's forehead with his thumb.] And this sign of the cross which we place on his forehead, thou accursed devil shalt never dare to violate."

It is stated on good authority that ninety-nine out of one hundred of the peasants in Wernding and the adjacent country believe in witchcraft, and are wont to attribute murrain and marasmus and all kinds of pestilence to this cause. To their minds epidemiology finds its simple and satisfactory solution in demonology. It is also an interesting fact illustrating the local persistence of superstition that the people of this region were notorious three centuries ago for the zeal and cruelty with which they persecuted and prosecuted witches. Thirty-five old crones were burned as witches in Nördlingen between 1590 and 1594, and equal ardor was shown in Neuburg and other towns on the Danube. One "witch," Maria Holl, was put to the torture fifty-six times without extorting a confession, and escaped further racking only through the intervention of Ulm, her native city. Had the woman Herz lived in those times she would have been unquestionably the food of fagots. She has the reputation of being an estimable person, and her husband has brought a suit for slander before the court at Anspach.

The author of the pamphlet in which Father Aurelian's report is embodied does not maintain that Michael Zilk was actually possessed; on the contrary, he is inclined to think that Father Aurelian may have been deceived. What he strenuously insists upon, however, is the reality of demoniacal possession, which, he affirms, can not be questioned by any Catholic or Protestant or Jew who believes in the truth of his Holy Scriptures. "It is an incontestable fact, confirmed by the traditions of all nations of ancient and modern times, by the unequivocal testimony of the Old and New Testaments, and by the teaching and practice of the Catholic Church." The criterion, *quod semper, quod ubique, quod*

ab omnibus, he thinks, applies here with peculiar force and fitness, for there is no philosophical or theological tenet resting upon a broader basis of universal consent. Christ, he says, gave his disciples power and authority over all devils to cast them out, and this same power is conferred upon every priest by his consecration, although he is never to exercise it without the permission of the bishop.

Incidents like that which took place at Wernding have been of comparatively frequent occurrence even in recent times. In cloistral and episcopal archives there are many records of this sort that have never excited public sensation because they were not reported by the press. In 1842 a devil named Ro-ro-ro-ro took possession of "a maiden of angelic beauty" in Luxemburg, and was cast out by Bishop Laurentius. This demon claimed to be one of the archangels expelled from heaven, and appears to have rivaled Parson Stöcker in antisemitic animosity. When the name of Jesus was mentioned, he cried out derisively: "O that Jew! Didn't he have to drink gall?" When commanded to depart, he begged that he might go into some Jew. The bishop, however, refused to give him leave and bade him "go to hell," which he forthwith did, "moaning as he went, in melancholy tones, that seemed to issue from the bowels of the earth, 'Burning, burning, everlastingly burning in hell!' The voice was so sad," adds the bishop, "that we should all have wept for sheer compassion, had we not known that it was the devil."

A more recent case in point is that of a lay brother connected with an educational institute in Rome, who on January 3, 1887, became diabolically possessed, and was exorcised by Father Jordan. In this instance the leading spirit was Lucifer himself, attended by a host of satellites, of whom Lignifex, Latibor, Monitor, Sefilie, Shulium, Ritu, Haijunikel, Exaltor, and Reromfex were the most important. It took about an hour and a half to cast out these demons the first time, but they renewed their assaults on February 10th, 11th, and 17th, and were not completely discomfited and driven back into the infernal regions until February 23d, and then only by using the water of Lourdes, which, as Father Jordan states, acted upon them like poison, causing them to writhe to and fro. Lucifer was especially rude and saucy in his remarks. Thus, for example, when Father Jordan said, "Every knee in heaven and on the earth and under the earth shall bow to the name of Jesus," the fallen "Son of the Morning" retorted, "Not Luci, not Luci—never!"

It would be easy to multiply authentic and official reports of things of this sort that have happened within the memory of the present generation; but they all offer in the main the same features, being characterized by grossness and grotesqueness, with

singular poverty of imagination, and would be rather monotonous and unedifying reading.

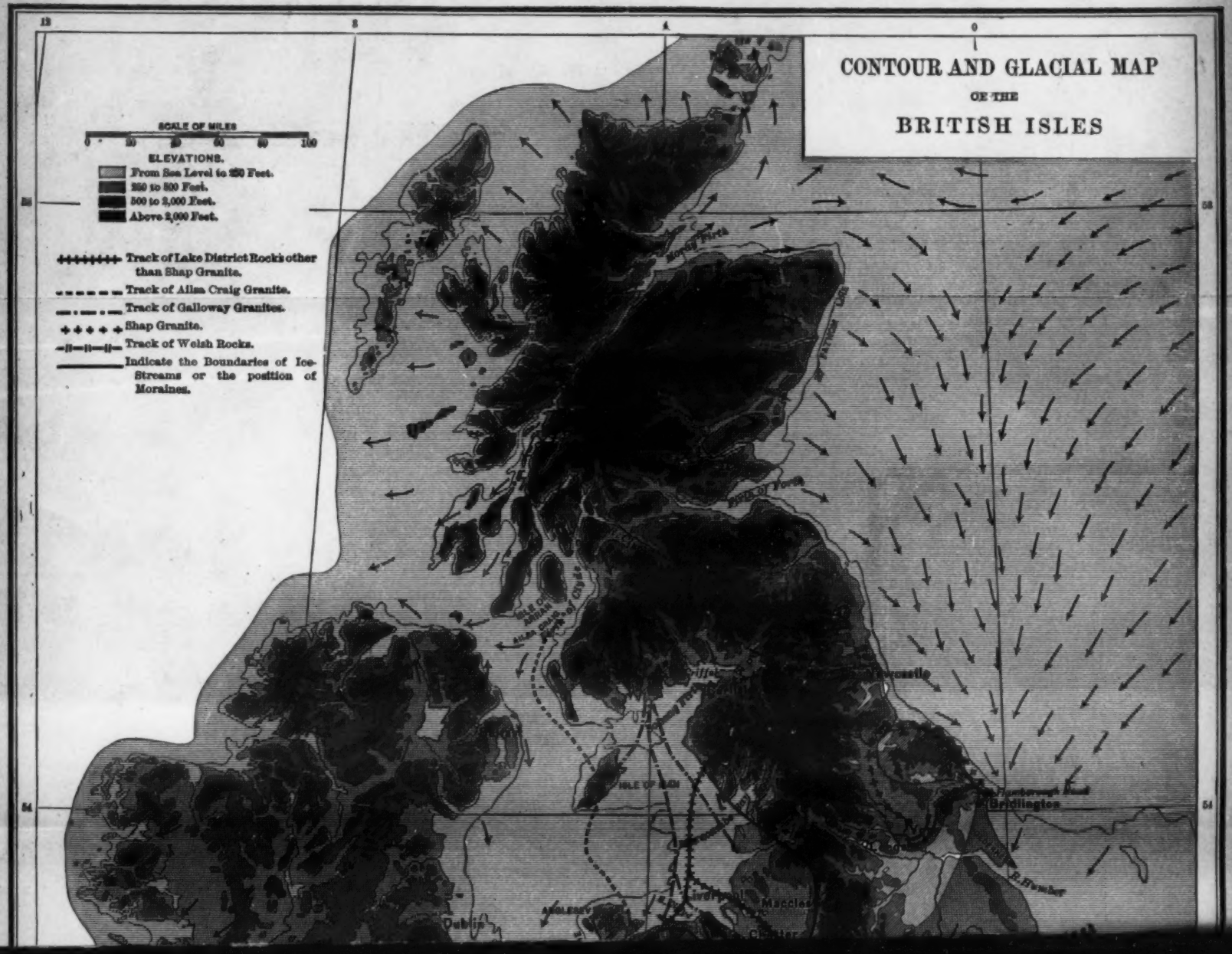
The principal signs of demoniacal possession, as given in ecclesiastical and most fully in monastic rituals, are the ability to speak or to understand foreign tongues unknown to the possessed, to tell where objects are hidden (like a mind-reader), the exhibition of supernatural bodily strength, intense aversion to holy places and to consecrated objects and persons, and the power of moving through space in defiance of the laws of gravitation.

A boy, who showed all these symptoms, was brought to Parson Kneipp, a Catholic priest, who has a much-frequented hydropathic establishment in Bavaria. Two priests had already declared the boy to be possessed, and had tried to exorcise him, but without effect. Parson Kneipp, who had learned to look upon phenomena with medical rather than with theological eyes, took a rational view of the case, and by a sytematic water-cure treatment healed the patient in six weeks.

It is true that the devil has been eliminated from the passion play at Oberammergau, in which he once took a prominent part, and amused the public by his clownish tricks. This change has been cited in proof of the progress of enlightenment among the peasants of the Bavarian highlands. No inference could be more incorrect. The devil disappeared from the stage, much against the will of the Oberammergauers, in 1810, by command of the Bavarian Government, which refused to permit a further representation of the play except on this condition. The text was then thoroughly revised and the performance remodeled by Dr. Ottmar Weiss, and Satan utterly banished from the scenes. The mass of the peasantry, nevertheless, believe in the devil and the reality of diabolic interference in human affairs as firmly as ever.

Modern science is doubtless doing a great work in diminishing the realm of superstition; but there are vast low-lying plains of humanity that have not yet felt its beneficent influence. "The schoolmaster is abroad"; but where he wears the cassock or the cowl, or is placed under strict clerical supervision, as the recent Prussian Education Bill proposed to do, the progress of intelligence in the direction indicated will be exceeding slow.

MR. C. W. KEMPTON remarks, in Science, that on a study of Schiaparelli's chart of Mars the systems of "canals" resolve themselves, in many cases, into groups of six, making hexagons, and giving the idea that the planet may be solidified into a mass, with tendency to hexagonal crystallization—the canals, for instance, being fissures on the lines of the angles of crystallization. This would account for many of the peculiarities of their appearance, while in no way opposing the present existence of atmosphere, water, snow, ice, and vegetation on the planet.


CONTOUR AND GLACIAL MAP
OF THE
BRITISH ISLES
SCALE OF MILES
0 20 40 60 80 100
ELEVATIONS.
From Sea Level to 250 Feet.
250 to 500 Feet.
500 to 2,000 Feet.
Above 2,000 Feet.
Track of Lake District Rocks other than Shap Granite.
Track of Alna Craig Granite.
Track of Galloway Granites.
Shap Granite.
Track of Welsh Rocks.
Indicate the Boundaries of Ice-Streams or the position of Moraines.
13
8
4
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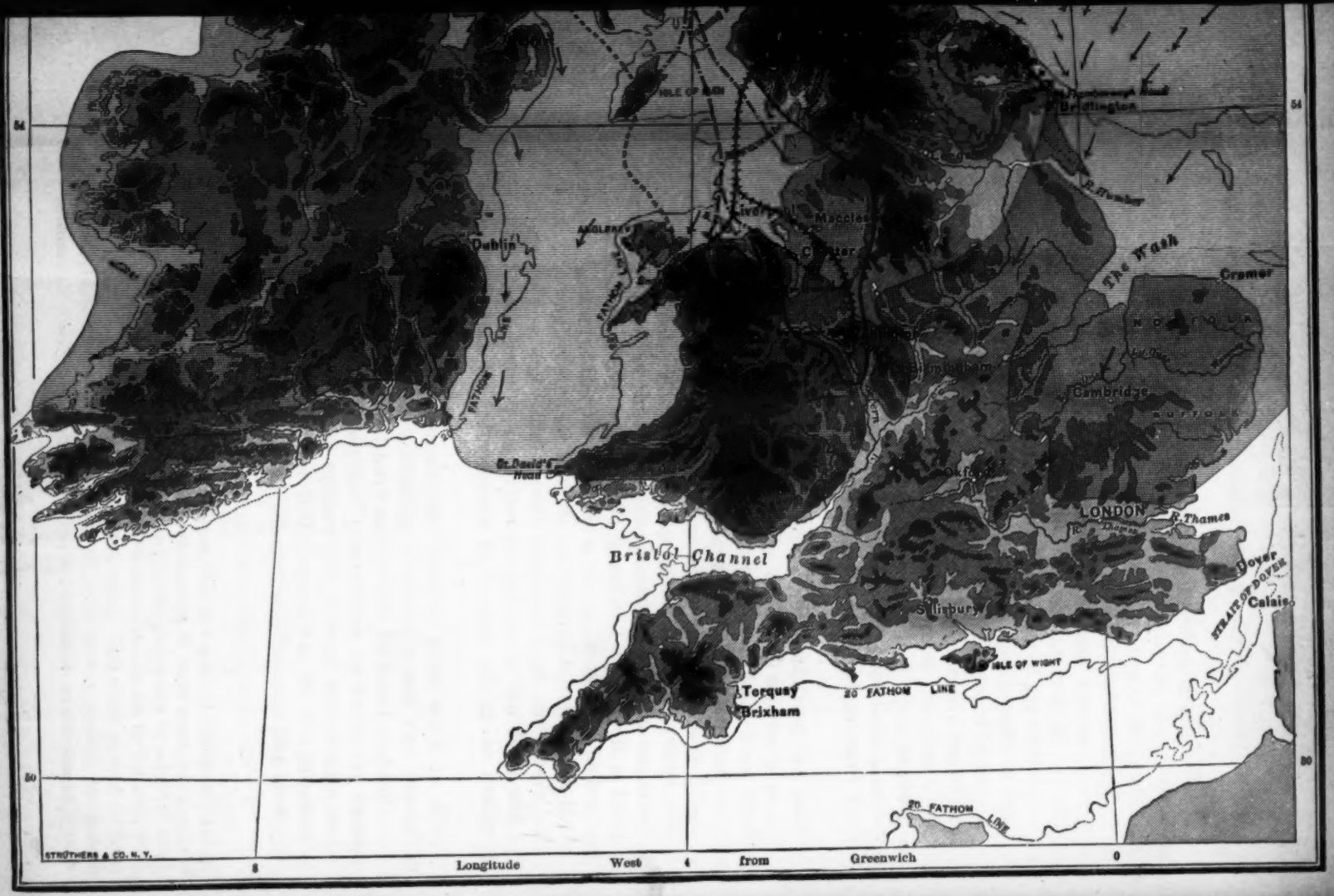
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RECENT GLACIAL DISCOVERIES IN ENGLAND.

THE accompanying map, prepared for Prof. Wright's new work on Man and the Glacial Period from data furnished by the latest investigations in Great Britain, embodies a vast amount of information, and for the most part tells its own story. It is largely the outcome of the work of the late Prof. Carvill Lewis, whose untimely death left his large collection of English notes still unpublished. But, in response to the interest aroused by him, a society embracing the most active geologists of northern England was formed to follow out and complete his work. The president of this society is Prof. Percy F. Kendall, now of Leeds, who prepared the chapter on the glacial geology of Great Britain for Prof. Wright's book, and who has furnished the principal data for the construction of this map. We are glad to be informed also that the field notes of Prof. Lewis, under the joint editorship of Rev. Dr. Crosskey, of Birmingham, and Prof. Kendall, are soon to be published by Mrs. Lewis in England.

Prof. Lewis was the first one to attempt a careful delineation of the boundary of glacial action in England and Ireland, as he was one of the first to do this work in the United States. Soon after Profs. Cook and Smock, of New Jersey, had published their map of the terminal moraine in New Jersey, Profs. Lewis and Wright took up the task of following it out through Pennsylvania. The results of their work there are embodied in Volume Z of the Geological Report of that State. Upon completing this work the two professors, by previous arrangement, divided the work of exploration—Prof. Wright carefully surveying the line westward to the Mississippi River, and with more or less care to Alaska, while Prof. Lewis went to England to do the work of which we have spoken there. Last year Prof. Wright also went to England, at the request of those who were following up Prof. Lewis's work there, and went over a large part of the most important ground under their lead; hence an unusual degree of confidence can be placed in the results which have been for the first time systematically presented in this map and the accompanying description. Space will permit us to give but the very briefest summary of the conclusions respecting English glacial geology, some of which are really revolutionary.

In the first place the investigations demonstrate beyond controversy that the glacial phenomena in the British Isles are the product of land ice, and not of floating ice. This may not seem very important to American geologists, who are all of one mind, but in England it means a good deal, where there are many who still cling to the old idea that icebergs and not glaciers

were the agency which scored the rocks and distributed the bowlders over the island. In the second place, these investigations have explained away, in a very complete and satisfactory manner, the evidence which had been supposed to prove that there was a submergence of the northern part of England and Wales during an interglacial period amounting to fourteen hundred or two thousand feet.

This evidence consisted of shell-beds inclosed in true glacial deposits eleven hundred feet above the sea at Macclesfield, near Manchester, and fourteen hundred feet above the sea at Moel Tryfaen, on the northern flanks of Snowdon, in Wales. Prof. Lewis, and those who have followed out the clews which he started, have proved that these shell-beds were not direct deposits during a submergence of the country, but rather beds washed out of true glacial deposits which had been shoved along by the ice in its passage over the bottom of the Irish Sea. The shells were pushed up with the mud from the sea-bottom, as pebbles are known to have been in so many instances. The melting of the ice furnished the water necessary for partially working over the original deposit and sorting out and stratifying the inclosed gravel and shells.

The demonstration of this theory of Prof. Lewis consists in showing that the deposits of shells are limited to those portions of the glaciated area which can be proved, by the transported bowlders, to have been overrun by ice which passed over the sea-bottom. Over this area shells are more or less mingled with the till, or bowlder clay, just as pebbles are, and limited beds of gravel and shells are of frequent occurrence, though the shells for the most part are very much broken up. An additional point of evidence of great weight is found in the fact that the shells are not such as would collect in the same place under water. In these beds rock-haunting and mud-loving species, and shallow-water and deep-water species are indiscriminately mingled together.

The course of ice movement is clearly shown on the map by the lines indicated in the transportation of bowlders. Briefly stated, the movements were as follows: Scandinavian ice flowed westward over the shallow basin of the German Ocean until it reached the coast of England from Flamborough Head to the latitude of London. It was warded off from Scotland and the northern coast of England by the glaciers which had preoccupied that region. Scandinavian bowlders are found scattered over the eastern counties of England, and there is evidence that the ice from that direction penetrated to the vicinity of London and up nearly to the head-waters of the Ouse and of the South Branch of the Humber. Meanwhile a glacial movement had been in progress

from the mountains of Wales, reaching eastward to Birmingham. But the two movements did not quite join. An unglaciated area was left between.

During all this time the Irish Sea was slowly filling up with the ice which was shed from the mountains of northern England, southwestern Scotland, and Ireland. This finally reached the obstruction presented by the mountains of Wales and divided—one branch of the ice-current going southwestward along the channel of the Irish Sea, and the other southeastward through the vale of Chester into the upper part of the Severn Valley. The bowlders transported by this movement are distributed down to a very definite line as marked in the map, and they overlie those from the Welsh mountains. It is in this area, containing bowlders from the lake district and southwestern Scotland, and in that covered with Scandinavian ice, that shells are found in the glacial deposits. Over the uncolored portion of the map and outside the limits of these two movements there is nothing to suggest a glacial or interglacial submergence. For a popular but full and comprehensive statement of the facts in the case the reader must consult Prof. Kendall's chapter in the volume from which we are permitted to copy this extremely interesting map.

CANINE MORALS AND MANNERS.

By LOUIS ROBINSON.

IT is always interesting to trace the various habits and attributes of our domestic animals which form the bond of their association with us back to their natural origin. In doing so we can hardly fail to reach some suggestive inferences which bear upon our own early history as well as upon that of the animals we study.

Most of our dumb companions and helpers have become modified by changing circumstances since the partnership began even more than ourselves, and have become partakers with us of the advantages and disadvantages of our civilization. This is especially so in the case of the dog, man's closest associate and earliest ally. The many who happily respond to his affectionate and loyal service by regarding him as worthy of the consideration of a valued friend will, it is hoped, follow with pleasure a few thoughts here put forward which have arisen from a study of the habits that now characterize him as compared with those of his wild relatives.

We must remember that although the dog is now our friend, with interests in the main in harmony with ours, he was not al-

ways so. The wild dog and wild man might have been chance allies when, for instance, a fatigued quarry pursued by the pack was struck down by a flint weapon, and the greater part of the carcass left to the original hunters; or when a wounded animal escaped its human foe to be followed up and devoured by the dogs. But, as a rule, the interests of dog and man would be conflicting, as is still the case where wild dogs exist, such as the dingoes of Australia, the dholes of India, and the hyena-like wild dogs of central and southern Africa.

It must be borne in mind that in dealing with these primitive canine creatures the word "dog" is used in its widest sense, and must include such animals as wolves and jackals, which undoubtedly share in the ancestry of our familiar domestic breeds.

Probably the partnership first began through small, helpless whelps being brought home by the early hunters, and being afterward cared for and brought up by the women and children. The indifference with which almost all savages regard their dogs seems to negative the idea that primitive man took the trouble to tame and train adult wild animals of this kind for his own purposes. The young dog would form one of the family, and would unconsciously regard himself as such. The reason why he should so regard himself will be discussed later when we come to consider the probable canine view of the relationship.

It would soon be found that his hunting instinct was of use to his captors, for while wandering abroad with them his keen nose would detect the presence of hidden game when the eyes of his savage masters failed to perceive it; and when a wounded animal dashed away, his speed and instinct for following a trail by scent would often secure what would otherwise have been lost. The dog in his turn would find an easier living and a better shelter while associated with man than if he were hunting on his own account, and thus the compact would be cemented by mutual benefits.

Now let us consider why the dog should so readily fall into the position of the companion and subordinate of man. What "stock and good-will" did he bring into the partnership besides his swiftness and powers of scenting and seizing his quarry? Let us look for a moment at his life at home as apart from his duties while hunting. In the first place, he evidently regards the dwelling of his master as his own place of abode in which he has certain vested interests, and, while he is complaisant and submissive to the regular inhabitants, he looks upon strangers of all kinds with suspicion, and regards their intrusion as an infringement of his rights or of his rudimentary sense of what is lawful. Although watch-dogs have doubtless been valued for many generations, and their distinctive qualities cultivated by artificial

selection, it seems clear that here we are dealing with an original instinct.

The pariah dogs of Constantinople and other Eastern cities, which are practically as untamed as their fellow-scavengers the vultures, crows, and jackals, and which probably have only in the slightest degree ever come under direct human influence, have the same habit.

Each street is the recognized dwelling-place of an irregular pack, and dogs—and in some cases even men—from other quarters are warned off or attacked if they cross the boundary.

It is said also that the wild dogs of India will drive off a tiger if he strays into the neighborhood of their chosen habitat. Even tame wolves will, without being taught, threaten a stranger if he comes near their master's house, but will take no notice of the coming and going of the regular inmates.

It would seem, therefore, that the watch-dog's peculiar virtue is directly traceable to the old instinct for guarding the lair of the pack. And in following this instinct the dog indicates that it is not his custom to act single-handed. The very fact that he growls or barks at a stranger shows that a vocal intimation to his fellows of the presence of a possible enemy is part of his plan. Every one has noticed that the barking of one dog will set off others within hearing, so that on a still night an alarm at one spot will disturb a whole suburb. Although no wolves or wild dogs are known to bark in the true canine manner, it is impossible to imagine that so distinct and almost universal a habit of the domestic varieties can have been deliberately initiated by man. Several instances are recorded of Eskimo dogs, and even dingoes and wolves, learning to bark by spontaneous imitation of domestic dogs. Foxes make a noise very like barking when they challenge one another among the hills at night, and it is not difficult to provoke an answer by imitating the sound under appropriate conditions. It seems probable, therefore, that the common ancestor of our domestic dogs and their wild relatives, which no doubt lived under somewhat different conditions from any modern feral creatures of the kind, was a barking animal.

As I have already said, the very fact that the dog barks when alarmed is an indication that he is a creature of gregarious instincts, and that he is accustomed to act in concert with others. The sound is a signal to his comrades as well as a threat to the intruder. If this be not so, what can be the meaning and intention of the different tones he adopts according to the nature of the provocation, which are capable of conveying to ears afar off an idea of the measure and nearness of the danger?

Most of our domestic animals, and all which act under our orders and give us willing obedience, are gregarious in their habits

when in the wild state. A little thought will show that many of the qualities for which we prize them are dependent upon this fact, and that we are the gainers by turning to our own use the stock of tribal virtues and morals which they bring with them into our service, just in the same way as we gain by appropriating the winter food-store of the bees, and the supply of starch and gluten laid up for future use by many plants. An animal of a troop has perforce certain social duties and obligations, which, as can be shown, are necessary for his own existence as well as for the welfare of the community. He must learn to give and take, and be prepared to follow and obey the members of greater capacity and experience. It is essential that he should be of a peaceable disposition, as a general rule, among his mates, so as to preserve the harmony of the band; since a pack of dogs, like a house, divided against itself will soon prove its unfitness, and be eliminated according to law. He must also be prepared to stand by his fellows, defend them or any of them if attacked, and warn them if danger approaches.

Seeing that most wild animals of the canine tribe prey upon quarry swifter and larger than themselves, their common welfare depends upon systematic and intelligent co-operation. A single hound following a trail by scent, will frequently be at a loss; for every now and then it will overrun and miss the line; but when several are together this will seldom happen, and the pace of the pursuit will consequently be much greater and the chance of a meal more certain. In searching for prey it is necessary for the pack to separate, so as to range a wider area, but the instant a "find" takes place it is important that all should be informed at once, so that a united pursuit may be taken up while the scent is warm. Among all hounds and many wild dogs the signal is given by the voice, but, as will be shown later, the dog has another and very perfect method of signaling in addition to this. For the canine tail, when considered philosophically, turns out to be nothing but an animated semaphore, by means of which important news can be telegraphed to the rest of the pack, in much the same way as messages are exchanged between different detachments of an army by the modern development of military signaling, popularly known as "flag-wagging."

Of course, in hunting all large and swift animals, a great deal can be done by strategy, and this involves a common plan of action often of an elaborate kind, and the giving and taking of orders by the leaders and other members of the band respectively. The value of quick perception and general intelligence, as well as of a readiness to co-operate, here at once become apparent, for without these qualities no such combination could be successfully carried out. Again, when the prey is within reach, it often re-

quires the united efforts of the whole pack, acting intelligently in concert, to pull it down. If a number of wolves or wild dogs were scattered over a district, each acting for himself independently, as cats do, large animals, such as the elk or bison, would be of no use to them as articles of diet, and they might starve in the midst of plenty. But if they combine and act under the guidance of experienced leaders they can at once utilize what would else be, in canine economy, a waste product.

As has been pointed out, this needful co-operation at once involves the elements of politics and morals. The obedience of the young and inexperienced to their leaders, and the observance of certain rules of conduct, are a *sine qua non* of the success of any strategic combination.

It follows, therefore, that the young of gregarious animals of all kinds, and especially those of this type, are submissive and teachable, and have thus the very qualities we desire in creatures which are to be trained for our special use. In fact, we have here the natural basis for that docility and readiness to obey which is such a noticeable and invaluable characteristic in dogs as we know them.

They must also be faithful to their fellows in word and deed. A hound which gives tongue when he has no quarry before him (and such canine liars are not unknown, as any huntsman will testify) may spoil a day's hunt and send the whole pack supperless to bed. It is interesting and amusing to observe the evident contempt with which the hounds of a pack regard an untruthful member. His failing becomes perfectly well known, and, let him bay as he will, not one of his companions will rush to the spot as they do the moment they hear the slightest whimper from a trusted and experienced finder.

Loyalty to one another is also a virtue which can not be done without. Thus we see that, however great the emulation between the individual members of the band, while the hunt is on it is kept strictly within bounds, and is subordinated to the common purpose. It is only after the game is captured and killed that contests of individuals for a share of the plunder commence. The very fact that an invitation is given to join in the pursuit as soon as the quarry is started, instead of the finder stealing off after it on his own account, is an illustration of this; and if one of the pack is attacked by the hunted animal at bay or by an enemy, his howls and excited outcry are instantly responded to by all within hearing.

Every one has noticed the uncontrollable power of this instinct when the yells and shrieks of a canine street brawl are heard. Dogs from all sides rush to the spot and immediately take part in the quarrel. The result generally is a confused free fight of a

very irregular description, and each dog is apparently ready to bite any of the others. It will easily be seen that this confusion is owing to a disarrangement of natural politics, caused by the disturbing and arbitrary influence of human institutions. If two of the combatants happen to be comrades, they will hold together and treat all the rest as enemies. In the wild state the sounds of strife would mean either a faction fight, or a combat with some powerful enemy of the pack, and probably in the former case every dog within hearing would be a member of one or other of the contending parties. By adopting dogs into our families and separating them from their fellows we upset canine political economy in many ways; but still the old loyal instinct to rush to the support of supposed friends in distress is so strong that a ladies' pug has been known to spring from a carriage to take part in a scrimmage between two large collies.

Among wild dogs the prosperity of the community might be fatally impaired by a lapse of this instinctive loyalty. All who have had to do with hounds know that every pack contains certain individuals whose special talents are invaluable to the rest. Generally one or two of a pack of beagles do most of the finding when driving rabbits in the furze, and in the case of a lost trail another individual will be, as a rule, the successful one in making skillful casts forward to pick up the line of scent. Another, again, will possess quicker vision and greater swiftness in running than the others, and the instant the game comes into view will cease the more tedious method of following, and dash forward at full speed to seize it.

Among wild dogs pursuing large and powerful game, the need and scope for such specialists would be even greater and more important. If one of these were lost through not being well backed up in time of peril, the whole pack would be the sufferers in a very material degree; for it would often fail to start, or lose during pursuit, some animal which might otherwise have been captured.

The study of this communal canine morality is very interesting when considered along with Mr. Herbert Spencer's theories of ethics. It is here dwelt upon, however, merely to explain, on scientific principles, many traits of our domestic dogs which (as is too commonly the case with those who receive benefits) we are liable to profit by and take for granted.

The great naturalist Cuvier observed that all animals that readily enter into domestication consider man as a member of their own society and thus fulfill their instinct of association. The probable view of the fox-terrier or the dachshund which lies upon our hearth-rug, therefore, is that he is one of a pack the other members of which are the human inhabitants of the house.

Most interesting would it be, were it possible, to get the dog's precise view of the situation. The chief bar to our doing so is owing to the difficulty of putting our human minds, even in imagination, within the restricting limits of the canine thinking apparatus. Thus we constantly see, when anecdotes of the cleverness of dogs are told, that the narrator is quite unable, in estimating the supposed motives and mental processes, to get out of himself sufficiently to escape the inveterate tendency to anthropomorphism; and he almost invariably gives the dog credit for faculties which it is very doubtful if it possesses. When we come to consider how few persons have that power of imaginative sympathy with their own kind which enables us to see to some extent through another's mental spectacles, it is no matter of surprise that a human being should generally fail in trying to think like a dog.

Thinking, after all, is, like flying, an organic process, dependent in every case on actual physical machinery; and dissimilarity of brain structure therefore absolutely precludes us from seeing eye to eye, mentally, with the lower animals.

But this structural difference of brain with its inevitable consequences, although it balks us in one way, comes to our aid in another. As has been said, our custom of ascribing human faculties and modes of thought is an involuntary and invariable one when we are dealing with the mental processes of other beings. Even when we speak of the supernatural the same habit is manifest, and human passions, emotions, and weaknesses are constantly ascribed to beings presumed to be infinitely more remote from us in power and knowledge than we are from the dog. Thus we see in the not very distant past, roasted flesh and fruits were thought by men to be acceptable to the gods; doubtless because they were pleasing to the palates of the worshipers, who reasoned by analogy from the known to the unknown. This should teach us to bear in mind that there is, affecting the dog's point of view, almost undoubtedly such a thing as *cynomorphism*, and that he has his peculiar and limited ideas of life and range of mental vision, and therefore perforce makes his artificial surroundings square with them. It has been said that a man stands to his dog in the position of a god; but when we consider that our own conceptions of deity lead us to the general idea of an enormously powerful and omniscient *Man*, who loves, hates, desires, rewards, and punishes, in human-like fashion, it involves no strain of imagination to conceive that from the dog's point of view his master is an elongated and abnormally cunning dog; of different shape and manners certainly to the common run of dogs, yet canine in his essential nature.

The more one considers the matter the more probable does

this view become. If we, with our much wider range of mental vision, and infinitely greater imaginative grasp of remote possibilities, the result of our reading and experience, are still bound by the tether of our own brain limits to anthropomorphic criteria when endeavoring to analyze superhuman existences, still more is it likely that the dog, with his mere chink of an outlook on the small world around him, is completely hedged in by canine notions and standards when his mind has to deal with creatures of higher and mysterious attributes.

At any rate, it will not be difficult to show that the dog's habits are generally consistent with this hypothesis. As far as mental contact is concerned, he treats his master and the human members of the household as his comrades, and behaves in many ways as if he were at home with the pack. Thus all the tribal virtues previously mentioned come into play. He guards the common lair and becomes a watch-dog, and by his barking calls his adopted brethren to his aid. He submits readily to the rules of the house because an animal belonging to a community must be prepared to abide by certain laws which exist for the common good. He defends his master if attacked—or, possibly, if not a courageous dog, gets up a vehement alarum to call others to his aid—because he has an instinctive knowledge of the importance of loyalty to a comrade, and because, as has been shown, loyalty to a leader is especially necessary. He is ready in understanding and obeying orders, owing to the fact that, when acting in concert with wild companions, it was absolutely needful that the young and inexperienced should comprehend and fall in with the purpose of the more intelligent veterans. The same ancestral habits and tendencies render him helpful as a sporting dog, and in herding or driving sheep and cattle. This last employment is very much like a mild kind of hunting, under certain special rules and restrictions, and with the killing left out. It has been observed that the Indian dholes will patiently and slowly drive wild animals in the direction of their habitat during their breeding season before killing them, so as to have the meat close at home; and this could only be accomplished by the whole pack exercising a patient self-control, and by the leaders constantly keeping in check the fierce impulse of the younger members to rush in and kill the weary and bewildered quarry.

The peaceable disposition and readiness to submit to discipline are also tribal virtues of which we take advantage. The dog, when he slinks away with drooping tail when reproved, or rolls abjectly over on his back and lies, paws upward, a picture of complete submission, is still behaving to his master as his wild forefather did to the magisterial leaders of the troop, or a victorious foe of his own species.

Jesse states that when a pariah dog of one of the Eastern cities desires to pass through a district inhabited by another pack, he skulks along in the humblest fashion, with his tail depressed to the utmost, and, on being challenged, rolls over, and there remains, limp and supine, submissively awaiting leave to proceed. The same thing can be observed when a large and fierce dog makes a dash at a young and timid one. This expressive and unmistakable method of showing submission is calculated to disarm hostile feelings, and contributes to peace and harmony, and therefore to the unity and prosperity of the body politic.

Although it would seem that the canine imagination from its very feebleness transforms man into a dog, yet, as we should expect, arguing from the cynomorphic hypothesis, it does not stop here. In Darwin's most interesting account of the shepherd dogs of the Argentine, given in Chapter VIII of his Voyage of the Beagle, he shows that, by a careful system of training, the herdsmen have taught the dogs to regard their charges as fellows of the same pack with themselves; insomuch that a single dog, although he will flee from an enemy if alone, will, as soon as he reaches the flock to which he is attached, turn and face any odds, evidently with the notion that the helpless and frightened sheep ranged behind him are able to back him up just as if they were members of a canine community of which he was leader. The passage is too long for quotation, but all who are interested in the subject should refer to it.

An instance of the operation of the cynomorphic idea can be seen in the behavior of a dog when a bone is given to him. He will generally run off with it to some quiet spot, and is supicious of every one who comes near him, evidently having the notion that what is to him a valuable possession is likely to be regarded as such by his human associates. Few dogs when gnawing a bone will allow even their masters to approach without showing signs of displeasure, and a fear of being dispossessed of their property, only consistent with the idea that the bipedal "dog" wants to gnaw the bone himself.

Every one has noticed the elaborate preliminaries which go before a canine battle. Teeth are ostentatiously displayed, the animals walk on tiptoe round one another, and erect the hair on their backs as if each wished to give the impression that he was a very large and formidable dog, and one not to be encountered with impunity. Frequently hostilities go no further than this, and one turns and retires with a great show of dignity, but plainly with no wish to fight.

When we come to analyze these proceedings, it will be seen that the ends of battle are often gained in a bloodless manner by this diplomatic exhibition of warlike preparations and capabilities.

The primary object of a hostile meeting between dogs (as well as between higher animals) is to decide a question of precedence, either general or particular. Now, if we could only settle which was the best man in any dispute by duels *à outrance*, a great deal of blood would be shed unnecessarily, and many valuable lives lost to the community. The introduction of moral weapons is therefore a great point gained, for injury to one is injury to all. The quick recognition of the superiority of a foe, and the perception of when submission should take the place of valor, is plainly of advantage to the individual, since a pig-headed obstinacy in resistance would frequently lead to elimination. Where in the serious business of life there is an interdependence of individuals associated for common ends, any influence which lessens the severity of internecine conflicts tends to the general well-being. Just as commanding officers have forbidden duels between members of an army in the field, so Nature has among gregarious animals, and especially those of predatory habits, discountenanced strife which might weaken the general efficiency of the pack.

Few animals excel the dog in the power of expressing emotion. This power is a sure sign of an animal which is habitually in communication with its fellows for certain common ends. Although probably long association with and selection by man have accentuated this faculty, a considerable share of it was undoubtedly there from the beginning, and was of service long before the first dog was domesticated. It is easy to see how important it is for the general good that the emotions of any one member of a pack of dogs should be known to the others. If, for instance, one of the number should perceive an enemy, such as a snake or leopard, lying in ambush, his rapid retreat with depressed tail would instantly warn the others of the danger.

There are many reasons for the tail being the chief organ of expression among dogs. They have but little facial expression beyond the lifting of the lip to show the teeth and the dilatation of the pupil of the eye when angry. The jaws and contiguous parts are too much specialized for the serious business of seizing prey to be fitted for such purposes, as they are in man. With dogs which hunt by scent the head is necessarily carried low, and is therefore not plainly visible except to those close by. But in the case of all hunting dogs, such as fox-hounds, or wolves which pack together, the tail is carried aloft, and is very free in movement. It is also frequently rendered more conspicuous by the tip being white, and this is almost invariably the case when the hounds are of mixed color. When ranging the long grass of the prairie or jungle, the raised tips of the tails would often be all that an individual member of the band would see of his fellows. There is no doubt that hounds habitually watch the tails of those in front

of them when drawing a covert. If a faint drag is detected suggestive of the presence of a fox, but scarcely sufficient to be sworn to vocally, the tail of the finder is at once set in motion, and the warmer the scent the quicker does it wag. Others seeing the signal instantly join the first, and there is an assemblage of waving tails before ever the least whimper is heard. Should the drag prove a doubtful one, the hounds separate again and the waving ceases; but if it grows stronger when followed up, the wagging becomes more and more emphatic, until one after another the hounds begin to whine and give tongue, and stream off in Indian file along the line of scent. When the pack is at full cry upon a strong scent the tails cease to wave, but are carried aloft in full view.

The whole question of tail-wagging is a very interesting one. All dogs wag their tails when pleased, and the movement is generally understood by their human associates as an intimation that they are happy. But when we attempt to discover the reason why pleasure should be expressed in this way, the explanation appears at first a very difficult one. (All physical attributes of living beings are, upon the evolutionary hypothesis, traceable to some actual need, past or present.) The old and delightfully conclusive dictum that things are as they are because they were made so at the beginning no longer can be put forward seriously outside the pulpit or the nursery.) No doubt, in many cases, as, for instance, the origin of human laughter, the mystery seems unfathomable. But this only results from our defective knowledge of data upon which to build the bridge of deductive argument. The reason is there all the time could we but reach it; and almost daily we are able to account for mysterious and apparently anomalous phenomena which utterly baffled our predecessors.

Probably the manner in which domestic dogs express pleasure is owing to some interlocking of the machinery of cognate ideas. In order to understand this better it may be helpful to consider some analogous instances with regard to habits of our own species.

One of the most philosophical of living physicians, Dr. Lauder Brunton, has clearly and amusingly shown that the instinctive delight and eagerness with which a medical man traces an obscure disease step by step to its primary cause and then enters into combat with it, is referable to the hunter's joy in pursuit, which doubtless characterized our savage ancestors when they patiently tracked their prey to its lair and slew it for glory or for sustenance.*

Mr. Grant Allen, I believe, first suggested that our apprecia-

* The Method of Zadig in Medicine, p. 5. Macmillan & Co. 1892.

tion of bright and beautiful colors, and therefore of the splendors of the flower garden or of the sunset tints in the sky, might be owing to the frugivorous habits of our very early progenitors, to whom the sight of red or golden ripe fruit was naturally one of acute pleasure. Supporting this startling inference (which is perhaps not so far-fetched as appears at first sight) is the very curious fact that occasionally, when we feel an acute thrill of pleasure from looking at a beautiful picture, or sunset, or indeed any harmonious combination of color which gives exquisite enjoyment through the eye, the salivary glands appear to be automatically stimulated, and "our mouths water" while we look. It is as if the old track of an out-of-date reflex between the part of the eye which takes account of color and the mouth—proceeding *via* what may be called the "pleasure centers"—were still open in spite of many centuries of disuse.

Another apposite illustration is the delight we derive from all manner of contests of wits and muscles, so that all our games, from whist to football, partake of the nature of strife for the mastery. A game is of course a systematic and recognized method of obtaining pleasure, and if we take a survey of all the most popular forms of enjoyment of this kind, we shall find that none of them are free from the element of that struggle for supremacy which has been a chief factor in the evolution of the human race, especially throughout the ages of barbarism.

Now if arboreal man took delight in discovering and devouring luscious and gorgeous fruits, and savage man in finding and hunting down wild animals, and barbarous man in fighting his rivals or the foes of his tribe—and all these ancient habits leave an impress upon our modern ways of seeking and showing pleasure—we can see that the dog's manner of manifesting pleasurable emotions may be traceable to certain necessary accompaniments of remote wild habits of self-maintenance.

As with man, so with the dog: civilization has made existence much more complex. The sources of pleasure of the savage man are few compared with those of the cultured and civilized, yet we find that the means of expression which we possess are but elaborations of those existing long before civilization began. We must, therefore, look at the dog's past history and find out what were his most acute pleasures, and what the gestures accompanying them, when he was a pure and simple wild beast, if we wish to elucidate his manner of expressing pleasure now.

There can be no question that the chief delight of wild dogs, as with modern hounds and sporting dogs, is in the chase and its accompanying excitement and consequences. One of the most thrilling moments to the human hunter (and doubtless to the canine), and one big with that most poignant of all delights, antici-

pation of pleasurable excitement combined with muscular activity, is when the presence of game is first detected. As we have seen in watching the behavior in a pack of fox-hounds, this is invariably the time when tails are wagged for the common good. The wagging is an almost invariable accompaniment of this form of pleasure, which is one of the chiefest among the agreeable emotions when in the wild state. Owing to some inosculation of the nervous mechanism, which at present we can not unravel, the association of pleasure and wagging has become so inseparable that the movement of the tail follows the emotion, whatever may call it forth.

An explanation of a similar kind can be found for the fact that dogs depress their tails when threatened or scolded. When running away the tail would be the part nearest the pursuer, and therefore most likely to be seized. It was therefore securely tucked away between the hind legs. The act of running away is naturally closely associated with the emotion of fear, and therefore this gesture of putting the tail between the legs becomes an invariable concomitant of retreat or submission in the presence of superior force. When a puppy taken out for an airing curves its tail downward and scuds in circles and half-circles at fullest speed around its master, it is apparently trying to provoke its pseudo-cynic playfellow to pursue it in mock combat. It may be observed that this running in sharp curves, with frequent change of direction, is a common ruse with animals which are pursued by larger enemies. The reason of it is thatthe centrifugal impulse acts more powerfully on the animal of larger bulk, and so gives the smaller an advantage.

Several years ago there was a good deal of discussion of the distinctive peculiarity of the pointer and setter, in The Field and other papers. It was suggested that the habit of standing still as soon as game was scented, instead of springing forward at once to seize it, was an instance of the manner in which a natural instinct might be absolutely reversed by training. One of the explanations attempted at the time for this apparent anomaly was, that the immovable position of the dog was comparable to the pause which most beasts of prey make before a final spring. But we must recollect, when considering this theory, that few of the *Canidæ* pounce from an ambush suddenly upon their prey after the manner of cats. And although a terrier will stand immovable before a rat-hole for hours together, his patient, watchful attitude is very different from the rigid and strained position of the pointer or setter; which position also has nothing in it suggestive of crouching, preparatory to a rapid bound forward, as is seen when a cat stalks a bird, and then gathers herself together before the final *coup*.

Not infrequently the tail of a young setter when it sets game may be seen trembling and vibrating as if it had a disposition to wag, which was kept in check by the supreme importance of not disturbing the hare or covey. The tail also is held out in full view like a flag, whereas a rat-catcher's dog on the watch at a hole will often droop its tail.

I think that there can be no doubt that the pointer and setter, in acting in their characteristic manner, are following an old instinct connected with an important piece of co-operative pack strategy, although the peculiarity has been enhanced by human training and selection, and the sportsmen with their guns have supplanted, and therefore act the part of, the dog's natural comrades in the chase.

The writer, during his boyhood, had charge of a small pack of beagles at a South Down homestead, several of which were allowed to run loose at night as a guard against the foxes. Among these was an old dog, a part bred Skye terrier, very sagacious, and well known in all the country round as a sure finder when the pack were used to drive rabbits in the gorse.

Old Rattler (what a throng of memories the name calls up!) was the recognized leader of the others, and not infrequently he would conduct them on a private hunting expedition, in which he served as sole huntsman and whip. Often on a still night his sharp yapping bark, accompanied by the clearer, long-drawn music of the beagles, might be heard among the hills, as they drove a predatory fox from the farm-buildings, or strove to run down one of the tough South Down hares. It soon became evident that this pack had a certain regular system of co-operation, and, like the African wild dogs, well described by Dr. S. T. Pruen, in his recent book, The Arab and the African, they made a practice of playing into one another's hands, or rather, mouths. Old Rattler would generally trot on ahead, surveying every likely tuft of grass or ling, and exhibiting that inquisitiveness and passion for original research so characteristic of the terrier. On arriving at a small outlying patch of furze he would invariably proceed to the leeward side, so that as the wind drew through the covert it would convey a hint of whatever might be there concealed.

He would give several critical sniffs, with head raised and lowered alternately, and then would either trot indifferently away, or else stand rigid with quickly vibrating tail and nose pointing toward the bush. The other dogs seemed to understand instantly what was required of them, and they would quickly surround the covert. When they were all in their place, and not until then, the cunning old schemer would plunge with a bound into the furze, and out would dash a hare or rabbit, often into the very jaws of one of the beagles.

By this artifice, which had never been taught them by man, the pack when hunting for themselves would doubtless often secure a meal, preceded by the delight of killing, without the wearisome process of tiring out a hare.

Now it appears to me that this habit of the leader of the pack —a habit which, from its similarity to what has been observed in the case of such widely separated *Canidæ* as the dingo, wolf, and hyena dog, is one that is traceable to very remote wild ancestors —is the basis of that peculiar talent in the pointer or setter which adds to the piquancy of a day's shooting and to the weight of the bag.

Let us endeavor to look at the part played by a pointer in the light of cynomorphic theory.

"Ponto" goes out with his pack (often a very scratch one), his comrades walking on two legs instead of four like ordinary dogs, and carrying their tails, or organs of a somewhat similar aspect, over their shoulders. The pack separate and advance in line, he being appointed to explore in the van and to search the turnips or rape for a tell-tale whiff of the scent of game. The covey is detected, but, being a co-operative and loyal dog, he does not rush in and try to catch for himself. He therefore stands and waits for his partners to perform their share of the stratagem. All that he has to do is to show them in an unmistakable manner that there is quarry worth having in front of his nose. The pack advance, he generally taking careful note of their approach, the covey rises, the "tails" of the bipedal dogs explode, and Ponto is rewarded by holding in his mouth a palpitating mass of feathers, with perhaps the stimulating flavor of blood, and by a public intimation that the community or pack approve of his conduct and esteem him, what he dearly loves to be thought, "a good dog."

When we come to consider the very long period during which dogs have been domesticated and under the influence of deliberate selection, it is surprising to find how much in their behavior they resemble their wild brethren. The rule seems to hold good here as elsewhere, that the outward form is much more plastic to the influence of environment than the character and mental habits which are dependent upon the nervous system. Thus, although the deer-hound and pug are so different in external appearance that it is difficult to believe that they are related, yet if we watch them we find that their mental and moral qualities are of a similar cast. The fine gray wolf in the Zoölogical Gardens, Regent's Park, and the performing wolves recently exhibited in London, when in a good humor, had precisely the same methods of expressing pleasure as the domestic dogs, and would wag their tails and gambol about in a manner which made one doubt for the

moment whether they were not in reality Scotch collies masquerading as wild beasts.

There are many other traits in our domestic dogs suggestive of their ancestral habits which can not be dealt with in this article, but which offer a most interesting field for study to every one who possesses a dog and a taste for research in this direction.

In concluding it may be well to notice briefly the chief points of dissimilarity between the wild and tame *Canidæ*. In the first place, there is a general difference of aspect and bearing which it is difficult to describe exactly. The wild animal has an alert, independent look which the tame one has lost, chiefly owing to its long-continued habit of dependence upon man. Although, of course, all breeds of tame dogs have been at some time or other deliberately adapted by training and selection for special purposes, yet there seem certain characteristics which have risen spontaneously, or because the parts in which they are manifest are correlated with some others where an intentional change has been brought about. Darwin gives an instance of this in the hairless dogs, which at the same time are deficient in teeth. This question of correlation is one of the most interesting and obscure problems of natural history, and perhaps we are at present a little too ready (with our hereditary tendency to take refuge in an imposing mystery whenever our reasoning powers fail us) to ascribe to it certain phenomena, the explanation of which by the ordinary laws of evolution is most clear.

Most probably the drooping ears of our domesticated hounds and hunting dogs primarily arose from the fact that the savage huntsman, disregarding shape, picked those dogs to breed from which manifested the keenest powers of scent, and that in these individuals the ears were not so much in use as with others. Again, in every litter of whelps the surly, independent, and ill-tempered brute would always be more likely to be eliminated than those which were confiding and tractable; and so, from age to age, the chief outward traits which distinguish the dog from wolves and jackals would tend to increase.

Finally, the instinct of association has, in the case of the domestic dog, become more exactly fitted to the new conditions of environment. He makes himself thoroughly at home with us because he feels that he is with his own proper pack, and not among strangers or those of an alien race. The wild animal, on the contrary, which refuses to become domesticated, still has the perception that those who would palm themselves off as his comrades are creatures of a different nature. He sturdily refuses to become a party to the fraud, and remains suspicious of their intentions; and, whatever they may do to propitiate him, he keeps on the *qui vive* as against a possible enemy.—*The Contemporary Review.*

PROTECTIVE DEVICES AND COLORATION OF LAND SNAILS.

By HENRY A. PILSBRY,
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THIRTY years ago, when Bates wrote his modest observations upon the protective mimicry of the butterflies of the Amazons, few naturalists could have foreseen the vital and far-reaching influence those now classic pages would have upon the future of biology. But the new doctrine, taken up by Darwin, Wallace, and others, and illustrated by hundreds of examples among insects, birds, and mammals, has already taken its place among the established canons of zoölogy.

The general principles of the subject of mimicry are now familiar to the laity as well as to scientists; but much still remains for observation at our very doors, to supplement the known facts, and to extend the underlying principles of mimicry and protective resemblance to the less-known groups of animals, among which are the land mollusks.

We have been made familiar with many cases of what may be called true mimicry, occurring among the insects; such as the conspicuous resemblance some moths, which are of course both defenseless and edible, bear to wasps and other stinging insects; and the instances of edible butterflies mimicking in their colors nauseous species are also well known. A more striking case of this phase of mimicry has quite recently been noticed in tropical America. In the forests of this region, leaf-cutting ants live in countless numbers. They strip whole trees of their foliage, carrying the leaves in fragments to their formicaries. Now, among these ants have been found insects belonging to an entirely different order, which mimicked the ant *and its leafy burden!* The back of the mimicking insect is green, and pinched up into a flat, thin plate, quite the counterpart of the leaf-fragment carried by the ant.*

A much more simple case is represented by the dead-leaf butterfly of Java, which, when it alights upon a bush, presents so close a resemblance to a dead leaf that even so experienced a naturalist as Wallace was long deceived by it. This resemblance of an animal to its surroundings may be called "protective resemblance," rather than mimicry.

Instances such as these might be multiplied indefinitely, were we to confine ourselves to the insect world. The great variety of

* See the article by Edward D. Poulton on this insect, Proceedings of the Zoölogical Society of London, 1891.

their *external* modification offers endless opportunities for the action of natural selection in producing mimicking forms in this great branch of air-breathing invertebrates. In the other great branch of invertebrate life, the land mollusks, the modifications of structure have been mainly *internal*. Outwardly they present comparatively few types. This sameness in exterior features has been unfavorable to the development of mimicking forms of mollusks; but, while true mimicry is rare among them, most interesting cases of *protective resemblance* and of special protective structures occur not infrequently.

I well remember hunting the snail *Helix thyroides* upon the wooded bluffs along the Mississippi. Both shell and soft parts of this mollusk have the brown tint of the fallen oak and hickory leaves with which the forest floor is thickly carpeted. Indeed, the colors correspond so closely that a person standing can scarcely distinguish snail from leaves, even when knowing where to look.

The assimilation of this snail to the general color-scheme of its environment must prove very beneficial; although one occasionally finds a heap of empty shells by the side of a fallen log or stump, showing that the jays and crows sometimes find enough of them for a meal.

It may be stated as a general rule that snails which live quite upon the ground have dark or dull-colored shells, while the shells of those living in exposed situations are bright. Turning to the tropics, where all Nature flaunts attire more gaudy than in the sober North, we find many illustrations of this rule. In the Philippine Islands there is a group of arboreal snails (*Cochlostyla*), some of which are vivid green in color, like the foliage whereon they live. It should be noted that these snails are so exclusively arboreal that they even deposit their eggs in a bag made by twisting leaves!

In tropical America we have a group of tree-climbing snails which subsist chiefly upon fruit. Like the Philippine Island species they are vividly colored; but in this case the colors are the most brilliant hues of yellow, orange, and red, corresponding admirably to the tints of the ripe fruits upon which they live.*

It is a noteworthy fact that certain ground-living allies of these brilliantly painted snails are dull colored, as are ground snails generally.

All the foregoing are instances of what has been called *cryptic*—that is, *concealing*—protective coloration. In other words, the

* Specimens of *Helix picta*, *H. alauda*, *H. marginella*, and other bright-colored fruit-eating snails of the West Indies, are occasionally imported to the Philadelphia and New York markets upon banana bunches.

color of the animal corresponds with the prevailing color of the environment, and thus it escapes the notice of its enemies.

A more complex state of affairs exists in those animals which make use of external objects for their own concealment. A case in point is the hairy snail (*Helix hirsuta*), a species commonly found throughout the Northern States, living around decaying logs in the forests. These little fellows have a clothing of short hair all over the shell, and this hair holds so much of the soil that they look more like small pellets of earth than like snail-shells. The disguise is effective enough to deceive more acute shell-collectors than the birds.

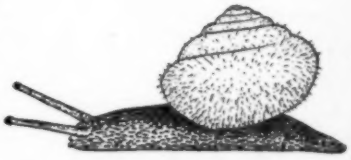


FIG. 1.—HELIX HIRSUTA. Showing hairy cuticle.

An altogether similar attempt at deception is practiced by a marine mollusk, the so-called "carrier." This gastropod has a broad spiral shell, to the upper surface of which it cements shells or pebbles, until finally it appears to be nothing more than a heap of shell-fragments, not distinguishable from any other irregularity of the sea-bottom. Another instance may be mentioned, as it illustrates the extension of this general principle to widely different groups of animals. The sea-urchins of our coasts have often been observed to cover themselves completely with small stones, so that nothing can be seen but a heap of pebbles.

Coming back to our hairy Helix, we may perhaps credit its hirsute coat with an additional function besides mere dirt-gathering. Poulton has observed that some insectivorous animals have an excessive repugnance for hairy insect larvæ, even when they

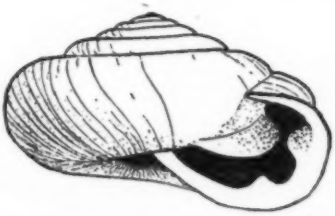


FIG. 2.—THREE-TOOTHED SNAIL, HELIX TRIDENTATA. Illustrating the simplest form of obstructing teeth.

FIG. 3.—CARACOLUS LABYRINTHUS—a South American forest snail. Showing extreme development of lip-teeth.

are not otherwise repulsive. The marmoset, for instance, can not be induced to touch *any* hairy larva. It is not improbable that small mammals, such as moles and field-mice, find the hairy covering of *Helix hirsuta* disagreeable, although we know that they eat other snails.

An old collector, who had spent most of his life within the

tropics, once related to me an experience of his in the West Indies, that throws light upon another phase of snail life, and reminds one of precisely similar incidents among the *Lepidoptera*. This naturalist had a habit of holding small snails in his mouth when collecting upon cliffs or trees where climbing was difficult. The light or dull colored species of *Cylindrella*, *Helicina*, etc., caused him no inconvenience, but the snails with conspicuously bright and shining shells, such as occur in the groups *Streptostyla* and *Varicella*, were so intensely bitter that he soon learned to let them remain unless he could carry them elsewhere. It is reasonable to conclude that birds find them equally unpalatable. The facts, as far as they are known, seem to indicate that this is an example of "warning coloration," such as many conspicuous but nauseous butterflies possess.

It may be remarked that the custom of holding specimens between the lips is not so rare with field naturalists as fastidious persons might suppose. I confess to having once swallowed a small and very rare specimen while so holding it for a moment. The creature was, alas! not my own property, and its outraged owner has not yet forgiven me.

A protective device totally different in kind from those just described has been observed in certain slug-like snails, which have the ability to amputate their own tails, just as a lizard does when seized by that appendage. Dr. Carl Semper has noticed this peculiarity in snails of the genus *Helicarion*, in the Philippine Islands; and a species of the genus *Prophysaon*, of California, has lately been seen to lose its tail in the same manner.*

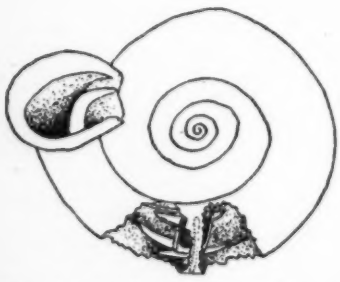


FIG. 4.—AN INDIAN SNAIL, ATOPA ACHATINA. Broken, to show the internal folds.

It is probable that the explanation is the same in the case of both lizards and snails—viz., the tail is likely to be the part seized by an enemy just as the escaping creature is disappearing into a sheltering crevice. The advantage of saving the head, even at the expense of the tail, is obvious.

Protective coloring and protective resemblance are, however, a defense only against the larger enemies of the mollusk, which hunt their game in the open, such as birds, field-mice, and incidentally, conchologists. But, besides these, snails have smaller foes which meet them upon their own ground. The omnipresent *Insecta* are

* See article by W. J. Raymond, Why does *Prophysaon* shed its Tail? The Nautilus, May, 1890.

the most troublesome of these, if we may judge by the elaborate means which have been evolved for protection against them. Beetles, especially those of the family *Carabidæ*, are not outdone by a Provençal vintner in their appreciation of a toothsome Helix; and it is interesting to watch the celerity with which a beetle of the genus *Cychrus* or *Dicælus* eats a snail out of his shell.

Various organs have been modified or developed to prevent intruders from entering the aperture of the shell. In one group of land snails there is a calcareous plate, called the operculum, secreted upon the upper surface of the fleshy foot of the animal. This plate is the last part to enter the shell when the animal retracts itself, and it fits closely into the aperture, closing it like a valve or door. Examples of this structure are seen in the common *Helicinas* of America and the genus *Cyclostoma* of Europe.

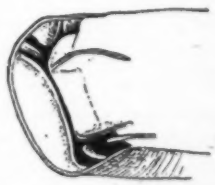


FIG. 5.—ATOPA ACHATINA. Broken, to show the narrowness of the passage between the folds.

The majority of air-breathing snails, however, are far removed genealogically from the operculum-bearing group, belonging, indeed, to quite a different phylum in which the operculum has never been developed. Failing this, a completely different structure has been adapted to the same use. From the rim or lip around the aperture spring processes of the shell substance, projected into the opening of the shell and decidedly narrowing it. An example of this structure in its primitive form is seen in the three-toothed snail, *Helix tridentata*, and its allies. The projecting "teeth," as these processes are called (although they have nothing to do with the true mouth of the animal), are prominent enough to exclude the larger beetles, and insects sufficiently small to be admitted would be drowned in the viscid mucus or slime freely exuded by the snail.

More complex is the obstructing mechanism in many of the snails of the Southern States and of South America. In some species—the *Caracolus labyrinthus* of Panama, for example—one wonders how the snail himself can get in or out of his own shell, so tortuous is the passage. These Southern forms represent the highest development of the three-toothed type of aperture. The meaning of this increasing complexity appears, when we remember that the regions where the most complicated types of snails are found are known to be practically coincident with the regions producing carnivorous *Coleoptera* in the greatest numbers and the most exuberant variety of forms. The writer once confined in a box with carnivorous beetles a number of snails with strongly "toothed" apertures (*Helix uvulifera*) and a number hav-

ing open, unprotected apertures (*Helix clausa*).* The former were found to be alive after several days, but the unprotected snails were eaten from their shells during the first night.

From tropical America we will now follow a great circle half round the globe, pausing in India or Ceylon. Here, too, the snails are exposed to the conditions of free competition for life in a tropical climate. What structures have been evolved in this totally dissimilar snail-fauna, corresponding to the evolution-products of American life under similar climatic conditions? As we would expect on *a priori* grounds, the protective structures, while strictly *analogous*, are in no way *homologous*, having arisen wholly independently in the two hemispheres. The Asiatic snails, instead of developing projecting teeth upon the edge of the aperture, have a system of calcareous blades or folds situated a distance within the shell, behind which the animal retreats when needful. The figures tell, better than any description, the extreme degree of complication which has been attained by the more highly organized forms. Beetles have occasionally been found sticking in the interstices of the folds, unable either to force their way into the interior or to extricate themselves and retreat.

The culminating point in the series of obstructive structures is perhaps reached by the narrow-throated snail of China (*Stegodera angusticollis*). In this bizarre form, the last of the spiral whorls is distorted and crowded against the preceding volution, producing an extremely narrow passage into the more spacious interior, as shown in the figure.

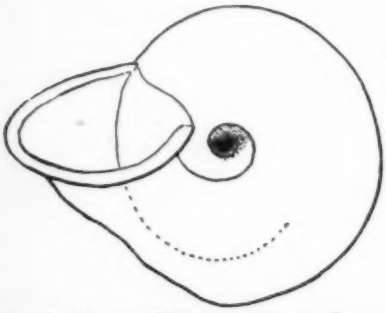


FIG. 6.—CHINESE NARROW-THROATED SNAIL. The narrow throat is shown by the dotted line.

But, in spite of these various expedients for the protection of the snail, they have some enemies able to overcome or to evade all obstacles. It is sad to learn that in this case, too, civil wars are the bloodiest; the most deadly of the "malacophagi" are brother snails of the genera *Selenites* and *Glandina*. When the hungry Selenites discovers a temptingly juicy snail, a Helicina perhaps, the victim retreats into his shell, barring the entrance with his strong door or operculum. The Selenites thereupon sets to work cutting a hole through the large whorl of the Helicina, in order to gain entrance behind the barricade. The tongue-like odontophore with

* The *Helix uvulifera* is a Southern, the other a Northern species.

which the mouth of the Selenites is provided acts like a file, being beset with minute teeth, each of the shape and sharpness of a bayonet; so that the cutting of a hole through the shell is only a question of time. Presently the shell wall is broken through, and Selenites feasts upon Helicina served raw on the shell.

So life is not without its tragic side, even with creatures so lowly organized as these!

THE ENVIRONMENT OF GRECIAN CULTURE.

By GEORGES PERROTT.

THE more closely we study the works of the ancient Greeks, and penetrate the secret of the thought which they loved to conceal under the veil of symbol and myth, the more plainly we recognize that their wise men half-saw by a kind of rapid divination many of the truths which have been demonstrated to modern philosophy only by series of methodically connected observations and experiments. There are few among the present theories of Nature, its forces and laws, of which some hint does not appear to have occurred, for a moment at least, to some of the philosophers of Ionia, Sicily, or continental Greece. In the study of man as living in society, or as what Aristotle calls the political animal, they pushed the rigor and subtilty of their analysis very far. How precisely Thucydides described the chronic or acute maladies of the moral sense and the changes it underwent, as at Corcyra amid revolutions that confused all established notions, and at Athens, when a fatal epidemic, offering the prospect of inevitable and immediate death to every one, impelled it to break from all constraint, and excited a thirst for pleasures to which there could be no immediate satisfaction!

The Greeks should also be credited with having outlined the doctrine that now holds the highest place in what we call the philosophy of history, of the influence exercised by the medium upon a race and a people. That theory, usually ascribed to Montesquieu, was foreseen by Aristotle, who accounted for the superiority of his countrymen by the intermediate position which Greece occupied between the cold regions of northern Europe and the warm countries of Asia; whereby, he said, the Greeks combined the energy of the northern barbarians with the mental vivacity of the Asiatics. The same doctrine was in fact presented a century earlier by Hippocrates, in his treatise on Air, Water, and Places, in which the last twelve chapters are occupied with it. Summarizing the results of a comparison between

Europe, or Greece, and Asia, and accounting for the differences he has determined, he says: "You will find as a rule that the form of the body and the disposition of the mind correspond to the nature of the country. . . . All that the earth produces is conformed to the earth itself," understanding the term earth in its most comprehensive sense, and regarding in its definition less the configuration and qualities of the surface than those of the climates that prevail and modify the fauna and flora. "If Asiatics," he affirms, "are of a more gentle and less warlike nature than Europeans, the cause lies chiefly in the equability of their seasons." And further, "A perpetual uniformity fosters indolence; a variable climate gives activity to the body and the soul."

We shall therefore only be following the counsel and the example of the great minds of Greece if we seek, in studying its history, to ascertain how and how far the character of its people has been affected by the action of "the air, the water, and the place." In our inquiry into the character of the medium in which the tribes called Hellenes in the eighth century before the Christian era were developed, we have enjoyed the advantage of a long residence in Greece, during which we have observed the people in their struggles with a Nature which gives nothing without being paid down, in labor of mind and muscle.

The peoples who figured in history before the Greeks, occupied territories clearly defined by Nature. Egypt was the lower part of the valley of the Nile, and did not extend materially beyond it. Chaldeo-Assyrian civilization was developed in the spacious basin of the Euphrates and Tigris; a much larger field, but still one that had definite boundaries—in the Taurus Mountains on the north, the rampart of the Zagros on the east, the Persian Gulf on the south, and the Arabian and Syrian Deserts on the west. The Phœnicians, indeed, had more than one capital, and carried their trade through all the then known world, but their capitals succeeding one another, each received its knowledge and art from the one that preceded it, and gave them to the one that followed it, and their intercourse with the world was animated by the commercial spirit only. Their industry never drew its inspiration from an intense and vigorous living art; and all that was essential in them was the product of the narrow strip of land between the sea and Mount Lebanon. All Hebrew art was restricted to a still narrower area in the circuit of Jerusalem and the little kingdom that depended upon it. There were other peoples in western Asia and Asia Minor who made their influence felt abroad: but within themselves each formed a compact mass, inhabiting a concrete portion of the continent, and it is within that limited territory that we have to look for evidences of their genius and work.

Greece, on the contrary, was multiple and diverse in space and in time. The name is more particularly applied to the easternmost of the peninsulas that the European continent projects into the Mediterranean toward Africa, in which the Grecian race, while it spread itself widely abroad, was most compactly settled; in which its cities of greatest influence and most immortal fame were built; and where were celebrated the Olympian, Isthmian, and Nemean games, to which all the scattered members of the Hellenic family periodically resorted. But, besides the peninsula of Hellas, as it was called, there were other Grecian lands, less eminently conspicuous, perhaps, which also performed their part, and that not an unimportant one, in the general movement of the race. There was Asiatic Greece, which by virtue of its brilliant and supple genius was more precocious than European Greece; which engaged first in the flights of poetry and art, and in general and distant voyages. There was a Greece in Africa, at Naucratis and the other cities among the mouths of the Nile, and in Cyrenaica cities, protected by the desert against invasion, and with its caravan-roads radiating in every direction into the interior, made it as a door opening toward the mysteries of the Southern continent. Thence a curiosity constantly on the alert brought data by means of which the limits of the known world were pushed further back, and the idea of the variety of men and climates was fostered.

On the opposite shores were the Grecian colonies fringing the gulfs and promontories of southern Italy, with their advanced posts pushed to the coasts of Gaul and Spain. They had the honor of being the earliest educators of Rome; and the monuments of architecture and sculpture which they have left are no less beautiful than those which originated on the soil of the mother-country. Between these Grecian lands, forming four well-defined groups on the mainland, each of which had its distinct existence, there was an insular Greece in the sea, including Sicily, the islands of the Adriatic, the islands south and east of Hellas—Cythera, Crete, the Cyclades and Sporades, Rhodes, Cyprus, Chios, Lesbos, the islands near Thrace, and many others, large and small. Men and merchandise, raw materials and manufactured goods, sacred images with the ideas and feelings they represented, the products of industry, and plastic types, were circulated and exchanged among these colonies with extraordinary facility; and happy meetings and fruitful contacts occurred in these hospitable archipelagoes, between Greeks and barbarians, and between Greeks of different stocks.

The race that was developed in this fortunate situation, favored by circumstances and by the medium in which it grew up, was perhaps the best endowed one that has participated in the

work of civilization. The Greeks had in the highest degree the genius for invention in letters and the arts. The other great peoples of their time reached a certain point and stopped there, afterward only repeating the types which they had created during their earlier period; or else were content to borrow and adapt; and, finishing their useful work before they lost their independence, continued to exist long after they had ceased to live and bring forth.

But Greece has always been progressive, or at least moving. Even when subjugated by the Romans, and when its series of original creations seemed to have been exhausted, it still cultivated science and history; attempted criticism; extended and sounded more deeply the ancient systems of philosophy; and took a part in the elaboration of the dogmas of Christianity.

In art, while its master sculptors and painters were extinct, its architects still produced great works without copying Ictinus and Mnesicles. The basilicas of Ravenna and the noble structure of St. Sophia are comparable in merit with the highest classical forms.

No organic development in the history of the human mind has been better known, or has been richer and at the same time more simple, than that of the Grecian genius. Notwithstanding the extent to which the Hellenic population was scattered, and the distances which separated the various groups, the evolution, taken as a whole, was governed by the same laws and exhibited the same phases in like order and under like conditions, in all the lands in which the Greek language was spoken. The different stocks were like trees of the same species, destined to produce the same fruits, the color and taste of which were liable, it is true, to be modified by local influences, but the variations were kept within narrow bounds. So these peoples were kept from greatly diverging by their constant communication with each other, which was aided by the forms and relations of their lands—promontories jutting out toward one another, and frequent islands; so that the sailor between distant ports was hardly ever out of sight of some Grecian headland. Nowhere else does the Mediterranean offer such a disposition; and there was in this geographical feature a direct provocative of the spirit of adventure.

The Hellenic peninsula is divided into two masses of nearly equal size—central Greece and the Peloponnesus—each of which is in turn divided into secondary peninsulas that have curiously irregular contours; while the islands are often so near to one another that one can pass between them or to the mainland with a few strokes of the oars. The waters in the sinuosities of the straits are always smooth; the deep bays lying in the recesses of the hilly shore; the narrow creeks concealed in the serratures of

the rocky coasts; the beaches on which vessels can be run to rest on the sands; landlocked harbors like that of the Piræus, capable of accommodating hundreds of ships—make Greece a country where the sea is so mingled with the land, insinuates itself into it and penetrates it in so many ways, that the inhabitants could not fail to trust themselves upon it as soon as they could hollow out a pirogue, familiarize themselves with the sea, and make it their highway. When the Greeks first appeared to view—in their epic poems—they were already bold sailors, fond of telling of the arduous voyages they had made and of the distant countries they had visited. They still keep their compact with the sea and excel as sailors; and their marine is an important element of Mediterranean commerce.

The roughness of their land made the Greeks all the more ready to accept the invitation offered them by the sea. The whole country is a single mountain mass of complicated construction and irregular expanse, the different summits of which have their several names; furrowed and carved by innumerable ravines and split by deep chasms, which often present precipitous walls. It has no high, broad, table-lands or large valleys; what are called plains there, except in Thessaly, where they are larger, being only narrow spaces nearly hemmed in by the mountains around, and notched by their intruding spurs. Where one must be always climbing, and descending to go up again, and is stopped at every few steps by some formidable obstacle, communication by land is not easy. It was therefore of great advantage and assistance to have the sea at hand to take one wherever he might wish to go, and, in order to enjoy it to the fullest, the Grecian colonists established themselves in such situations that each group should have at least one seaport. Only one considerable community, the Arcadians, had a wholly inland home, and they were regarded as generally behind the others in enterprise, learning, and civilization. Without the sea and the outlets it offered, the peoples who occupied the Hellenic peninsula would probably have continued in a condition of barbarism and anarchy, like that with which their relatives, the Albanians, are still struggling; without it they must have been doomed to that indefinite state of division in which the clan rules. The passage by land from one district to another was always arduous and often impossible. The local groups seemed doomed to live in perpetual isolation, with no room for a truly large and fruitful national development. That their influence became more prominent than might have been anticipated was because of a special feature that modified the effects of the general configuration of the land. Nearly all the mountain-walled districts of Greece had one side open to the sea, and that gave passage to everything—persons, goods, and ideas. Storms could close

this road only a few days at a time, while through all other seasons the ships could sail freely, promoting an incessant exchange of visits and mutual favors among districts between which Nature had within placed the restrictions of numerous and high barriers.

The attachment of the Greeks to the sea was confirmed by the regularity and mildness of the winds. This sea and these winds favored the moral unity of Greece, which it enjoyed till the time of the Roman conquest without ever having political and administrative unity. Until the capture of Corinth by Mummius it was divided into a number of cantons separated from one another by Nature, which were as many independent states. This universal presence of the sea furnishes a means of accounting for the superiority of the part which Greece has played in the world. The country, while it was free, had no roads, and did not need them. It was easier and more convenient to spread sail, in order to go from one place to another, than to climb the mountains and coast along the precipices. It would have been hard to find, even outside of the very numerous class of professional sailors, a Greek who had not, once at least in his life, left his native village or city for purposes of war, commerce, pleasure, or piety. The last two motives were confounded in practice. The desire to consult a renowned oracle, or to attend the festivals celebrated in honor of the great national deities, caused the movement, every year, of thousands of Greeks, many of whom came from a great distance—from remote parts of Asia, Europe, and Africa. These festivals held a place in the lives of the Greeks of which we, subject to the tyranny of professional duty and the cares of business, can hardly form a conception. We can imagine that the attendants upon them, during the few hours they passed together, would have much to tell one another and to learn, and would improve the opportunity. Can anything be fancied better than these removals and meetings to awaken the mind and keep it on the alert, and thus to forestall the estrangement with which the race was threatened by reason of the dispersion and wide separation of its branches? The Greeks of Hellas could refresh and increase their knowledge by conversation with those of their brethren who, like Ulysses, had "seen cities and learned the thoughts of many men." The citizens of the most remote colonies, those who lived in small groups among barbarians or in the oases of the desert, having taken part in the periodical solemnities at Athens, Delphi, or Olympia, could return more Greek in feeling and thought, manners and language. Like the giant of one of their fables, they had recruited their strength by touching the mother's bosom of the country of which they were children.

Greece was thus at once central and scattered; central in Hellas, scattered and multiplied in the periphery. The great body

had its interior circulation; its blood was sent out to the extremities, and from the limbs returned to the heart to be purified there and charged anew with the nutritious elements that kept up the life and originality of the race, and gave it its superior energy. It had the mobility of the waves, which, after they had sown the Grecian colonies all along the shores of the Mediterranean, were incessantly bringing them back to their native country. The sea, when they were still an infant and savage race, brought them the germs of civilization from the East. Through it they received the figures and the rites of divinities, the worship of which was destined to bring men together and make them social—writing, metals, and the processes and implements of the principal arts. The sea placed the Greeks in relations of the most favorable character with foreign nations; in such relations as are suggestive and not oppressive. It permitted frequent intercourse and prolonged visits, but did not lend itself readily to attempts at invasion. The peril from this source was the less in the early days of Greece, because the chief military powers of those times had no navies on the Mediterranean; and when Persia was ready to send armed fleets to achieve its conquest, Greece had become mature and had capable commanders and well-managed fleets.

Greece was further protected in the days of its development, on the continental side, by the formidable chain of Hæmus or the Balkan Mountains, behind which it was enabled to work out its destiny unobserved and unmolested by the barbarian peoples who were moving and marching beyond them in the valley of the Danube. South of these rise in succession the mountains that envelop Thessaly with their ramifications westward, and the Cambunian Mountains, both crossed only by narrow and difficult passes. When these were forced, and the enemy was in Thessaly, he had to scale other barriers no less difficult in order to reach the plains of Bœotia; and then, to get from each small state to the next, he had to surmount the other considerable chains that severally separate them, where he was constantly liable to be exposed to the eyes and arrows of the native population. Even if, after overcoming all these obstacles, a conqueror succeeded in penetrating to the end of the last redoubt, a slight accident might any day turn his triumph into a disaster. All the doors which he had opened might be closed upon him in an instant. "Greece," says M. Michelet, "is made like a trap with three bottoms: you find yourself caught in Thessaly, then between Thermopylæ and the isthmus, and at last in the Peloponnesus." It is a great advantage to a people to feel that it is secure in the country it lives in.

This peculiar disposition of their territory further enabled the Greeks to try the experiment of municipal government, and to demonstrate the excellent results it can give to a happily en-

dowed people. This government is that in which the idea of the city and that of the state are merged; in which each city is a living body, all the members of which take a more or less direct part in the administration of public affairs.

It is not without some surprise that we learn from history how at once intense and scattered was life in the whole Hellenic world, from the eighth to the third century B. C., and what organic potency, what intestinal activity, and what expansive force were possessed by each of the little states which the vigor of Grecian genius had scattered over all the Mediterranean shores. This municipal life was endowed with a mobility and variety that were not exhibited elsewhere. The minds of the people, easily receptive to the beautiful and the true, were stimulated to reflection by letters, philosophy, and science, and matured rapidly. Rhetoric, placed at the service of private and public interests, bred an eloquence which was fed by broad ideas that raised the dignity of party strifes. On all the theatres of action, before which the attention of the audience was never relaxed, the politician, artist, poet, writer, or orator—the man always in sight and in action—never ceased to display his passionate energy; while the lively emulation of these cities, at once rivals and sisters, none of which would submit willingly to be less than the others, or let them achieve a glory in which it could not have a part, augmented the ardor of the universal effort. Thus we find in the creation of the city the source of the high originality of Greece, and the stimulant to its real work—the building up of ancient civilization.

The relief of the land in the Hellenic peninsula and its dependencies gave rise to the city. The nature of the country and the climate had a salutary influence on the development of what Alfieri calls "the human plant." The land co-operated with the sea in promoting the supple and robust development of the body and the alert action of the mind. The life of the sailor inures the limbs and adapts them to all kinds of motion; with its constantly imminent perils, it exacts coolness and watchfulness and makes the mind quick to perceive and precise in observation. There were few Greeks who had not lived more or less on the sea and received some education of this kind.

Even those Greeks whose occupations kept them habitually ashore were subjected to somewhat similar influences. The land is one of sharp contrasts. One can pass in a few hours' walk from the vicinity of almost eternal snows, through forests of beech and fir, to plains where the palm-tops wave. Marked contrasts appear in the distribution of water. Gravelly ravines, in which ribbons of verdure, of laurels and tamarisk, are the only sign of the existence of a stream beneath the surface, are a predominant type; on the western slopes of Hellas are limpid streams,

flowing in little cascades like the Neda, or full to the banks like the Ladon; rivers like the Alpheus and Achelous, which can not be forded even in the dry season; with Lake Phenæa, in the Peloponnesus, resembling the lakes of Switzerland. Yet water is rare and inestimably precious; and that explains the worship that was given to the nymphs of fountains, and the care that was taken in art to give them forms of beauty corresponding to the honors which popular piety rendered to them.

The climates are as various as the physiological characteristics of the landscape. On the shores of the bays and on the islands the difference is slight between the mean temperatures of the cold and the warm seasons; but in the interior, in the closed valleys, the winters are severe and the summers hot. With such varieties of land with its hundred faces, and the sky with its hundred caprices, body and mind are kept under perpetual strain to adapt themselves to the complex and mobile conditions of media that are modified with a rapidity that discounts all forecasts. Within a very narrow space are men of the same race and language leading very different lives accordingly as they dwell on the mountains, the high pastures, the cultivated slopes, or the shore. One who removes from one of these zones to another is obliged to modify his habits, to add or take off something of his clothing or his food, and perhaps to learn and exercise a new occupation. This tends to stimulate the organs and give elasticity to the mind, which is constrained by the force of circumstances to improvise the methods of action which the conditions demand. Thus everything concurred to develop personal energy among the Grecian people, and to fortify and build up the race by virtue of the law of the survival of the fittest. While infant mortality has always been very high, in consequence of the abrupt contrasts, those constitutions which succeeded in adapting themselves to them acquired a singular elasticity.

The marvelously clear atmosphere and bright skies of Greece give the vision a delicacy which the sense can not attain where all the contours are enveloped in vapors. There is thus developed in it the habit of studying, comparing, and measuring forms from a distance; and it acquires in that practice those qualities of a just perception and a quick feeling of the exact relations of the different parts of a whole which, in the age when they were applied to the interpretation and reproduction of the living form, contributed to make the Greeks the first artists in the world.

Artistic excellence was further favored by the very composition and nature of the rocks of Greece. The rocks of some districts, when disintegrated, furnish an excellent plastic material, equally suitable for bricks or tiles, and for modeling under the fingers of the potter and sculptor; and when they retain their

consistency and hardness, although of unequal quality, they readily adapt themselves, with a little care, to the purposes of the artist. Certain shell tufas were convenient for use as a stucco, to cover deficiencies of material and give it color. A solid stone, such as is found at the Piræus, was adapted for precise cutting and exact joining, to a rhythmical arrangement of the blocks and a firm accentuation of the moldings. More careful pains was encouraged when marble of a finer grain was used. It was a material that inspired the workman with a kind of involuntary regard, for it assured him that none of his intention, no delicate stroke of the chisel would be lost; and this gave that wonderfully accurate execution so much admired in the sculptures. There were, further, marbles of different colors, which could be combined and arranged for the best effects. The adaptability of these materials to the sculptor's work was hardly a less potent factor in the development of Grecian art than were the natural genius of the race and the conditions of its environment.

On the other hand, Greece was poor in metals, the lead and silver mines of Laurium being the only mines on the peninsula that have been worked with profit. The fact brought its advantages. The people could not do without metals; they needed them for domestic luxury and ornament. The metallic treasures found at Mycenæ and other evidences are in proof of the power of their taste for gold, and they shrank from no danger to get it. Both it and the humbler metals had to be got from abroad; and the necessity must have contributed to the development of business and enterprise. It would dispose the people to welcome the foreigner bringing them the commodities they desired, and then to go in search of them in the countries where they occurred or were brought in by trade. All dependence, including dependence in trade, is a bond; and it is important that it shall not operate to reduce one of the two parties brought into association by it into vassalage to the other. That danger was not to be apprehended in Greece. The situation and configuration of the country were calculated to foster individuality and independence in all things, and to protect the beginnings and favor the development of the nation which should first establish and hold itself there as in an impregnable fortress.—*Translated for The Popular Science Monthly from the Revue des Deux Mondes.*

Mr. Conway, who is exploring in the Himalayas, finds the peaks difficult in their lower parts; the region above seventeen thousand feet is easy, but in bad weather one is cut off from the upper region by the next seven thousand feet below. There are numerous and vast glaciers descending to between eight thousand and nine thousand feet above sea-level.

PREHISTORIC CANNIBALISM IN AMERICA.

By Rev. A. N. SOMERS.

IN the summer of 1888 I took a club of young people belonging to my church to the famous ruins of the mound-builders at Aztalan, Wis., for a day's outing, and exploration of the mounds of that once great village. A superficial survey soon convinced me that it had been a very populous village, as it covered at different times as much as two hundred acres, down to an area of a little more than seventeen acres, which was skillfully and strongly fortified, representing the increased intelligence and caution of several generations constantly shrinking under the ravages of war and possibly cannibalistic devastations.

A first effort located the communal refuse-heap, where had been thrown the refuse and garbage of the village, when it covered an extent of nearly one hundred acres for a very long period of time.

In these heaps one generally learns more of the manner and means of subsistence of the prehistoric people than from all other sources of conjecture combined, for in them are thrown the bones and refuse of their meat-supply, and the broken cooking and other utensils. Broken weapons and ornaments likewise find their way to the garbage-heap, just as with us. But when the mound-builder broke his tools, weapons, and ornaments, they could not be reduced back to raw material, to enter into the construction of something else, as do many of our worn-out or broken implements, for they were made of material, in the main, that would not permit of such transformations. Those, then, no longer useful were thrown, along with the bones and other insoluble and almost imperishable refuse, into a common heap in some convenient place where they would afford the least annoyance.

A few hours' work in this heap was rewarded by over five hundred valuable relics, including broken pots, arrows, ornaments, hoes, and bones—no less than one hundred of which were human bones, in about equal proportion with the bones of beasts, birds, and fishes.

A subsequent trip to the same place, in company with Prof. J. Q. Emery, Principal of the High School at Fort Atkinson, added nearly one thousand more bones to the collection. Another trip to the place, in company with an amateur collector of relics, added about six hundred more bones to the collection; I now have nearly two thousand bones from the refuse-heap, forty per cent of which are human, while the remainder are evenly divided between birds, beasts, and fishes.

This refuse-heap covered a space about one hundred feet long

by forty wide, in a low place where a ravine emptied a surplus of surface water into the river at wet seasons of the year. The accumulations were often covered by clay from the hillside, so as to have stratified it to a depth of eight feet in the lower part of the original ravine, making it later almost level with the surrounding river bottoms.

The bones other than human are bear, raccoon, buffalo, moose, deer, squirrel, woodchuck, rabbit, wolf, pigeon, quail, ducks, reed-bird, turtles, pickerel, pike, perch, bull-head, and suckers.

The crushed shells of land snail, periwinkle, and the fresh-water clams were in great abundance.

Several of the strata show the action of fire on their surface, as if the attempt had been made to burn them over, to destroy the refuse.

The human bones in this heap were subject to the same treatment as those of the beast, and lay often in actual contact with them, and in every one of the strata.

The bones containing marrow were all either broken into short pieces or split open. The mark of the stone knife and axe is to be seen on most of them, where they were hit to break or split them, or in severing the joints. The ribs were cut into short bits, seldom over three inches in length; and always the knife-marks are seen on the inside, except where they were severed from the vertebral connection. This treatment is the same in both those of the beasts and men.

Among the number of human bones thus found one can identify many different skeletons. Some of the skulls were very thin and compact, showing a large and uniform curvature, while others were thick, spongy, and of irregular curvature.

The largest and coarsest bones, and those lying in the topmost strata, bear a striking resemblance to the bones of the Fox and Winnebago Indians slain in the Black Hawk war, many of which I have examined and compared with these.

In contact with one of the skeletons of the highest type, I found beads cut from the shell of *Busycon perversum*, a marine shell-fish, an inhabitant of the Gulf of Mexico. In another garbage-heap similar to this one, twelve miles distant, on the same stream, two whole shells of the *Busycon* were found by another man some years previous.

A beautiful paint-dish, or mortar, was found by another party in the same locality.

I found broken bone awls, stone drill-points, and half-finished arrow-heads, as well as thousands of pieces of broken pottery. Many weapons of war and implements of agriculture have been found scattered over the entire surface of the village site, and the hundreds of acres of garden-beds adjoining it.

The only implements of a warlike nature found in the garbage-heap were in the topmost strata, from which fact I would infer that their early occupation of this place had been a peaceful one, with the introduction of wars with rival tribes at a later date, forcing them to learn warfare as an art of defense.

The shrinking of the village site from so large an area to so small a one as the last walled in for more sure defense indicates the rapid depopulation of the village and increased danger of assault.

In one quarter of what I regard as the second epoch of the community I estimated as many as two thousand foundations of tepees. In that same portion of the village site, Dr. Lapham, in 1853, or about that time, took out of a grave in one of their temple foundations fragments of cloth made from vegetable fiber. They seem to have been a comparatively civilized people, among whom agriculture and manufacturing were carried on, and great order displayed in laying out their village and defending it with walls and other devices.

Of their cannibalism there can be no doubt after these discoveries. Had they been slain and eaten by their enemies, or by other tribes conquering them, their bones would not have been mingled with those of beasts, birds, and fishes taken in the same locality, and evenly distributed through eight feet of accumulating silt carried from the hills by a stream that only had water in it at extremely wet and short periods of the year, where the accumulation is not over three inches in a century, since the timber has all disappeared, and the plow has turned the soil every year for about forty years.

That the flesh of those bodies was eaten there can be no doubt, for no savage would go to the trouble to mutilate the dead bodies of friend or foe, to the extent of separating all the joints with a knife, chopping the bones three or four inches long, and splitting all those and only those containing marrow, and then finally mixing them with the bones of the animals he undoubtedly used as food, and throwing them into one common heap.

The diversity of the skeletons as indicated in their texture and physiological configurations would suggest to my mind that the persons eaten were probably taken prisoners in battles, with possibly some of their own number eaten as a sacrifice in their festivals and orgies, of which they must have had many, as indicated by the temple-like structures that existed among the variety of structures built by them. Their social life must have been highly developed, to hold them together in one village, and to create such strong defenses as its walls indicate, and to carry their industries to so high a degree of perfection as is indicated by the relics referred to above.

The government of so large a body of primitive people would

call for an elaborate mythology to invest its rulers with the necessary civil power to hold the society together, and wield its combined strength against its foes from behind the walls that protected its women and children, and to till the soil and make its wares. The pottery, of which there must have been great quantities, from cooking-pots over twenty inches in diameter down to drinking-pots not over three inches in diameter, seems to have all been made from clay taken from three or four pits, and all baked in a single kiln.

There was probably some division of labor among them; some making pots, others tilling the fields, while still others made tools of various sorts, and still others may have followed the chase for meat-supplies. All the birds of which I found bones are migratory, and are found in that locality only during the period of the year in which the crops would need attention. The same is true of some of the fish upon which they fed.

Whatever led to cannibalism among them fixed the habit so permanently in their lives as to lead them to relish human flesh. Every part of the body seems to have been eaten, which would not be true of those cannibals that eat their enemies for revenge or in religious sacrifices. In those cases they seldom eat more than small portions selected according to the demand of some superstition that does not apply to all of the body, even to the marrow.

The fact that such ornaments as the shell beads, which must have been highly prized by their owners, were thrown with the bones into the common garbage-heap of the village would seem to indicate that the person eaten, and whose bones and ornaments found a common fate among the bones of food-animals, was alien to the eaters.

Then, too, very wide differences of anatomical conformations exist between the bones in the garbage-heap and those buried in the burial mounds adjacent to the village. This confirms the notion that the victims eaten must have been taken by the chase, or as prisoners of war. The bones indicate all ages, from children of tender years to aged men and women. There seems to have been no discrimination as to the age and sex of the victim, as is generally the case when a human body is eaten in religious or social orgies. Such are the facts in confirmation of this habit having existed among a people of a high order of barbarism.

The manner in which, and the length of time it was practiced by them, would indicate as its cause the development of a relish for human flesh through a scarcity of food. The very fact that they were populous, and subsisting in a latitude that has hard and long winters, together with the uncertainties of the returns from their primitive agriculture, would confirm the notion that hunger was its cause, and that its pressure never was unfelt until the relish

for human flesh had been fully acquired, after which it would continue its hold upon them, even if the need of it was slight.

The Indians of the Northwest have been known to eat their enemies slain in battle, yet the practice never extended to the consumption of the entire body, down to the particular habit of cracking the bones to get the marrow.

RECENT APPLICATIONS OF PAPER.

By M. EMMANUEL RATOIN.

THE year 1891 was certainly one of those in which new industrial applications of paper were most numerous. The idea of using paper in place of stone in the construction of houses is already old; but paper to take the place of glass in windows, of clay in flower-pots, of iron in railway rails, wagon-wheels, and horseshoes, of porcelain in laboratory ware, of wood in barrels, it having already taken the place of that material in small boats, paper in pulleys, are applications as novel as bold. The manufacture of window-panes of paper was first tried in the United States. The panes have the appearance of milky glass, and the property of intercepting the light-rays while letting the heat-rays through, which makes them suitable for greenhouses. It is estimated that a paper window-pane ninety-four by sixty-three centimetres in dimensions in a wooden sash with iron appliances, will cost about eighty-five cents, and last on the average four years.

One of the most ingenious of the new applications of paper is in pulleys. These pulleys, the invention of M. Burot, have a center of cast iron and spokes of iron, bearing a bracing on which the paper felloe rests. This bracing supports the felloe during its manufacture, and thus gives it more firmness. The paper, of a special quality, is glued, rolled, and compressed upon the bracing in a single operation. The crown should then be dried and dipped in a mixture of linseed oil and resin. These pulleys, much lighter than those of iron, are also appreciably cheaper. They are used for the transmission of forces of from a half horse power to four horse powers.

Paper flower-pots have the advantage over earthen pots of being unbreakable and much lighter. If their net cost were considerably less than that of the earthen pots, they might replace them in the immense use made of them by gardeners and forest cultivators. They are imputrescible, impermeable, and shed the water. Like similar articles in terra cotta, they are adapted to ornamentation. Covered with a coat of enamel, or painted, they have the advantage over ornamental earthen pots of lending

themselves more readily to the fanciful forms which manufacturers like to impose upon them.

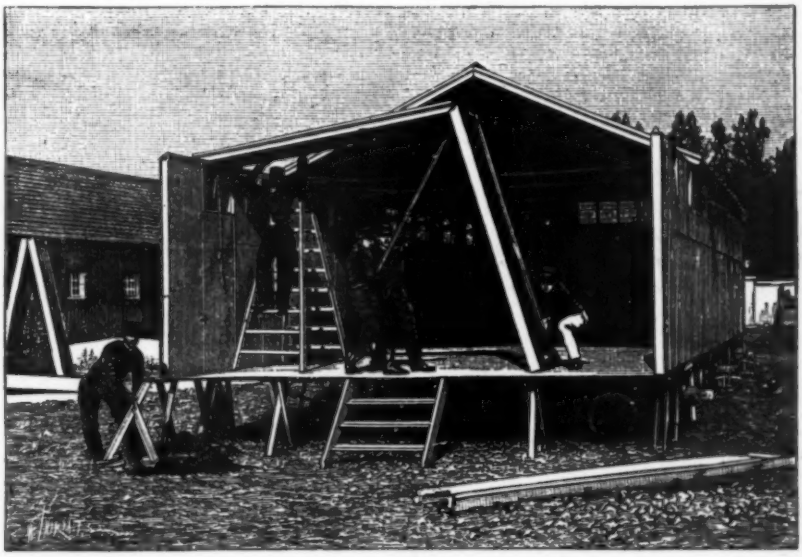
M. A. Petit, engineer, has described to us the processes of manufacturing them thus: A paper pulp is taken composed of eighty-five parts of wood pulp and fifteen parts of rag pulp, and is shaped in molds to the desired form. The pneumatic or the centrifugal process of molding is used, according to circumstances, and does not differ essentially from those employed in porcelain factories. The articles are dried in air and then desiccated in a current of warm air; after which they are placed in an iron cylinder of one cubic metre capacity, which can be hermetically closed. A vacuum is formed in the cylinder in order to withdraw the air from the objects which are placed in it, and is maintained for four hours, after which a liquid composed of petroleum essence, colophony, linseed oil, and paraffin is admitted; this liquid being heated to a temperature of 75° C. before it is let into the cylinder. The articles are kept immersed in it for a quarter of an hour, when they are withdrawn and placed in a similar cylinder heated to 100° C., for the purpose of expelling the petroleum and recovering the solvent for use in other operations. The articles having been dried, are exposed in a stove for five hours, at 75° C., in a current of electrified air, or air containing a considerable quantity of ozone, for the oxidation of the linseed oil which fills the pores of the pulp. They are then plunged for an hour in a bath of linseed oil, castor oil, and colophony; exposed again in the stove to air and ozone, after which they are completely impermeable, flexible, and proof against acid.

The adaptability of paper for the construction of canoes has been proved by the strictest tests, and the canoes have been found to be practicable boats; but the manufacture of them has not been as prosperous an industry as might have been anticipated.

On the other hand, the application of paper in house-building has been crowned with success. A builder's establishment founded several years ago took for its device *"Neither wood nor iron"*; and its houses, built almost exclusively of pressed paper, are curious specimens of what may be done with that material. The element of the construction is a panel, usually three metres by one metre and sixty centimetres, and a tubular beam ten centimetres in thickness, and composed of two walls of pressed paper four millimetres in thickness, fixed upon a frame, likewise of paper. The pieces composing this frame are V or U shaped; and these devices, capable of giving extremely light joists or beams, are not one of the least original of the conceptions of the system. The elementary panels do not weigh more than forty kilogrammes apiece; they are easily handled, and they fit at their edges so as to constitute the wall. The roof is com-

posed of similar panels fastened in pairs. They rest on the walls against which the corner-pieces of paper abut. Although the thrust is weak enough, the two parallel walls are connected by a number of tie-beams composed of thin wire of galvanized iron, particularly if the construction consists of a long hall without any bearing wall. By means of the double walls, which inclose a cushion of air all around the construction, we get houses nearly insensible to variations of temperature, and consequently very comfortable to live in. The floor is composed of panels about a metre and a half square, constituting a wall of paper six millimetres thick, nailed to V-shaped wing-beams.

The use of these houses may be particularly commended for temporary constructions. They are remarkably well adapted to



HOSPITAL ON WHEELS. (Espitallier system.)

places used for exhibitions, for ambulance services, military campaigns, etc. Hospitals made upon this system appear to have given very satisfactory results. Besides the general advantages accruing from a rapid building, the particular fact may be taken account of that the paper used in the construction of the walls may be made with antiseptic water, which will communicate to it the precious quality of not harboring germs of infection.

[An ingenious portable hospital or barracks of paper, the invention of M. Espitallier, captain of engineers, is described in another number of La Nature, by M. J. Comportey. Its interior dimensions are sixteen by five metres, and it will accommodate twenty beds. Folded up, it forms a load for three two-horse trucks.

When it is to be set up, the three trucks, the length of which is equal to the width of the building, are brought up so as to be parallel in line and a few metres distant from one another, and are arranged so that their floors, which are to form part of the floor of the building, shall be on a level. Light T-shaped joists of iron are stretched across the intervals, supported by trestles when necessary, to receive the paper panels completing the floor. The other details of the structure are substantially as described by M. Ratoin. The interior of this building is entirely satisfactory, without visible framework, and without posts to interfere with the arrangement of the beds or with the circulation of the air. The walls, and the ceiling, which is inclined according to the inclination of the roof, are closely jointed and varnished, and consequently easy to wash and disinfect. The only open joints are the vertical couplings, which can be inspected and cleansed by simply taking them apart. The windows are of wire gauze covered with a transparent coating so as to avoid the inconveniences of glass. Ventilation is effected through holes bored at the angle of the ceiling and the wall.—ED. P. S. M.]

We do not purpose here to review all the new applications that have been made of paper, but have intended only to take notice of some of the principal ones, and to call attention to some of the improvements that have been made in them. To the other uses—in wagon-wheels, barrels, horseshoes, etc., mentioned in the beginning of this article—we may add a notice of the experiments that have been made in the use of paper in the manufacture of some articles of furniture, such as tables and folding chairs, the principal advantages of which evidently lie in their lightness. These experiments have been timid enough; but no long time will elapse before paper, which already has its masons and its carpenters, shall also have its cabinet-makers.—*Translated for The Popular Science Monthly from La Nature.*

RECENT analyses of the air of larger towns, made by a committee of the British Association for the Advancement of Science, and reported by Mr. G. A. Bailey, show: 1. That in clear, breezy weather the amount of sulphurous acid is less than one milligramme per one hundred cubic feet of air. 2. That in anticyclonic periods it rises very considerably, and in times of fog, *maxima* of thirty-four and fifty milligrammes have been recorded for the worst districts of Manchester and London respectively. 3. That wherever an open space or a less densely populated area occurs there is a very marked diminution in the amount of impurities in the air. 4. That an increase in the amount of sulphurous acid is accompanied by at least as large an increase in the amount of organic impurities in the air. 5. That smoke, promoting as it does the formation of fog, and preventing free diffusion into the upper stratum of the air, must be regarded as the principal cause of the impure state of the atmosphere in large towns.

DEAFNESS, AND THE CARE OF THE EARS.

By ABRAM MILLS FANNING, M.D.

IT is astonishing to realize how little is known by the laity of the simplest rules for the preservation of health.

It would be amusing if it were not so shocking, because so ignorant, to know of some of the curious remedies used by people otherwise intelligent. Owing to this widespread, dense ignorance of simple medical facts among our people, positive harm is done, irreparable in many instances.

Our blind asylums contain many cases of what are known to physicians as cases of "preventable blindness"—the sight forever destroyed by the use of some "old woman's remedy," as tea-leaves, for instance, persisted with until damage too great to be successfully combated by the physician is done to the sight.

It is the popular idea that the deaf and dumb are always born with that affliction. Of course it is not so. As a rule, there is no radical defect of the organs of phonation; but children born deaf can not talk because they have never heard and learned any words. Many are the children, blessed with perfect hearing and consequent speech for the first two, three, or four years of their lives, who, in consequence of improper or no attention to their ears during an attack of measles, scarlet fever, or diphtheria, have totally lost all sense of hearing; and their ability to talk has then gradually diminished and disappeared also. Our deaf and dumb asylums are filled with just such cases of "preventable deafness."

This popular ignorance of ordinary medical truths can be attributed in great part to the disinclination of reputable physicians to write popular articles for the enlightenment of general humanity. Most of what has been written of a medical nature for the general reader has been confined to advertisements of patent medicines.

Probably the two most important senses are those of seeing and hearing; and it is of these same two that the least is known by the general public, and that the greatest number of absurdly ridiculous, dangerously improper popular remedies are used. It is the purpose of this writing to correct in some measure this misconception in regard to the ears.

A recent experiment was made by the writer at one of our large eye and ear hospitals in this city to obtain some approximate idea of the proportion of people who really have perfect hearing among those who believe themselves exempt from any defect of the auditory apparatus. Without previous warning, twenty-five eye patients were selected, care being taken to have none but those who had never suffered from any, even temporary,

defect of hearing. Of the twenty five, not more than five could be said to enjoy perfect hearing. Four fifths of the patients tested had impaired hearing, and had never suspected any defect whatever.

Of all the native-born inhabitants of New York and vicinity and of residents who came here in early life before their respiratory passages were fully developed, probably a not very much smaller percentage have lost some of their ability to hear perfectly.

The normal ear is capable of hearing considerably better than is necessary for the ordinary purposes of civilization; in fact, is endowed with what may be termed "superfluous hearing." Proper tests will discover the loss of even a small portion of this superfluous hearing, and warn us that we are gradually becoming deaf—in fact, already partially deaf—although we may not have noticed the slightest deficiency. This explains why it is that many victims of certain forms of chronic deafness believe their complaint to have been sudden in its beginning, when in reality it has been progressing for several years; the longer time having been occupied by the gradual loss of the "superfluous hearing," and the patient's attention not having been directed to his affliction until the "necessary hearing" was encroached upon.

The great majority of all forms of deafness are dependent upon and directly resultant from affections of the nose and throat.

In the city of New York and vicinity, owing to the extreme variations of the temperature and climate from day to day, it is indeed a rarity to find among the people who have lived here any time a perfectly healthy nose and throat. Such repeated sudden extremes of hot and cold damp weather, which are so common in this location, are ruinous to the throats of even temporary visitors with perfectly healthy respiratory organs; and the effect is so marked, the condition so universal among the inhabitants of this city, that children of catarrhal parents are born with a swollen, catarrhal condition of the inside of the nose and throat which within very few years closes the nostrils so that proper respiration is impossible, and the child becomes what physicians call a "mouth-breather." We meet these children constantly in the streets. The climate of Brooklyn is even worse in this respect.

From the condition of a "mouth-breather" it is but a short step to one of two results—more often both: deafness, and that peculiarly stupid, sleepy, inane, foolish expression of countenance so characteristic of the "mouth-breather."

To parents who have the welfare of their children at heart, such a warning as this should be of sacred importance. As soon as the child gives evidence of a tendency to breathe constantly

through its mouth, just so soon should intelligent medical investigation be made of its nostrils, preferably by a proper specialist.

It is quite common for a child's mouth to drop open when asleep, although he may have been breathing through his nose when falling asleep. To correct this tendency it has long been a custom among many mothers to tie a folded handkerchief over the child's head and under its chin to keep the mouth closed. But it is cruel and dangerous to do this unless we are positive that the child can breathe easily through the nose.

Snoring also should be a warning, because snoring is usually due to breathing through the mouth, and mouth-breathing is due to the swollen, catarrhal condition of the inside of the nose; and it is this condition which is the cause of dry catarrhal deafness, which is by far the most frequent form of deafness.

Most of our population have some general ideas of catarrhal affections of the nose and throat, but very few except those who have lost their hearing from it have any conception of its intimate causal relation with deafness. The popular idea of catarrh is that it is a condition of more or less constant discharge of offensive mucus from the nose. This is so only in the most aggravated and worse forms of the disease, and fortunately is rare. Properly speaking, catarrhal affections of the nose and throat are simply an enlarged, swollen, and thickened condition of the lining membrane of the nostrils and back part of the throat. This thickened condition of the mucous membrane in the nose is usually accompanied by an increased production of mucus, which often drops backward into the throat, and, by increased moisture in the back of the throat, excites the continuous little hacking cough to dislodge it and clear the throat.

These patients are very subject to what are called "colds in the head," with complete closure of the nasal passages. The reason their colds in the head are so severe is because a very slight swelling of the inside of the nostrils, which is always the condition in this acute disease, occurring in a nose already much narrowed by a chronic permanent enlargement of its lining membrane, totally obstructs the nasal canals.

A very common but unhealthy remedy for temporary or permanent occlusion of the nose is to snuff a solution of salt and water through the nostrils. Unfortunately, this practice has been too often thoughtlessly recommended by family physicians. If the habit is prolonged, the condition for which it is used will surely be aggravated. A much better solution to use in the nose, and also as a gargle in acute sore throat, instead of chlorate of potassium, is common baking soda (bicarbonate of soda), a teaspoonful in a cup of warm water. Whatever solution is used in the nose, it is a great mistake to forcibly snuff it into the nostrils from

the palm of the hand, as is too commonly done. If it is snuffed too forcibly, it is forced into the upper part of the nasal cavity, where it is very irritating, often causing headache and irritation of the eyes. The best and simplest way to use the soda solution is to bury the nose entirely in the cup of fluid, and then gently suck the solution into the nose, at the same time holding the mouth widely open. There is no risk of choking if the mouth is open and the head thrown forward, as it necessarily is in doing this, for all the fluid will run out through the mouth. A few trials will readily demonstrate the advantage of this method over all others.

Probably all the laity, so to speak, when first they realize that their hearing is diminished, believe that the wax has accumulated and has blocked the auditory canal. The sensation to them is certainly one of obstruction, and they seem justified in picking at the canal of the ear in attempting to remove the obstructing substance.

With very rare exceptions, deafness is never due to wax alone. In the majority of cases it is really due to obstruction, but this is very much farther in the head than any patient can reach, and often of too dense a nature and too long duration for even the specialist in otology to successfully eradicate. Even where there certainly exists a mass of wax entirely blocking the auditory canal, with it is always associated an underlying catarrh of the drum of the ear without any discharge from the ears whatever. The effect upon the hearing is like that caused by closure of the canal, and wax alone is suspected. In the effort to remove the suspected obstruction, matches, toothpicks, hair-pins, etc., are used in the ears, and perhaps a little of the normal wax which belongs in the canal is removed, and the patient's suspicion seems to be verified.

It must be emphasized right here that the ear-scoops and ear-sponges for sale in all drug-shops are worse than useless; they are positively dangerous. Many are the ears that have been incurably injured by such instruments. There is more wisdom than humor in the old saying that we ought to put nothing in our ears but our elbows. At any rate, let no one put anything into the auditory canal but the end of the little finger wrapped with a handkerchief or a towel.

If deafness is of sudden occurrence, accompanied by a dull, rumbling sound in the ear, similar to that caused by temporarily closing the canal of the ear by the finger, with a sensation of fullness of the canal, and absolutely painless, obstruction from accumulated wax may be suspected. But there is no means of positively determining this, except by having the ear carefully examined by some competent observer.

To remove impacted wax, the same baking soda (bicarbonate of soda) is the best preparation to use. A teaspoonful of the soda should be mixed with just enough warm water to dissolve it; this should then be dropped into the ear until it is filled, and allowed to remain in contact with the wax for five or ten minutes. It is to be repeated three times during the day; and then the ear should be thoroughly syringed with a quart of hot water. No other syringe than the fountain douche should be used.

For ordinary purposes a good douche can be extemporized from an old quart bottle by attaching a convenient length of rubber tubing to its mouth, and, filling the bottle full of the hot water, invert it and allow the water to flow through the tubing into the ear.

Other forms of deafness are too deeply seated to be dealt with by any one but a specialist.

The earliest symptom of beginning deafness in many cases is a ringing sound in the ears. Many patients describe it as a noise all through the head rather than in the ear itself. It is at first intermittent and occasional. The ringing may be present for some time, scarcely perceptible, when suddenly the sound will change, becoming much louder, and the note jumping high up in the scale, where it will continue to ring quite loudly for some minutes, and gradually die away, to appear again some time afterward. It may reappear in a few hours, as the trouble with the ears progresses. Ringing in the ears may also be the prelude to an acute attack of earache; but it is here followed very soon by pain, which so predominates over the ringing that it is no longer heard.

If the hearing is properly tested just as soon as the ringing in the ears has become more or less constant, some degree of deafness will be detected. As the case progresses, even before all the so-called superfluous hearing has been destroyed, the patient will realize that he is becoming deaf. For this condition there is nothing to be done by the patient himself. Advice from a physician should be obtained just as soon as diminution of hearing is suspected.

Much can be accomplished, however, by the patient toward preventing the deafness becoming worse. Careful attention should be devoted to the general health, to keep the nose and throat in as healthy condition as possible—to prevent "taking cold," especially colds in the head. Exposure to changes of weather should be avoided; the feet never being allowed to become wet, or, if they do become wet, the shoes and stockings should be changed for dry ones as soon as possible. Turkish baths and plenty of outdoor exercise are strongly to be recom-

mended, to stimulate the circulation and inure the system to changes of weather.

Another great class of troubles which is sadly misunderstood by the public is the acute inflammations of the ear. There are few pains in the human body more distressing than earaches. Many have been the nights of agony passed with pain in the ear, because the proper remedy has not been known in the household.

Almost every conceivable thing has been used for earache by patients of high and low degree. With the exception of baking soda, already mentioned—and I have considerable hesitancy in trusting even that to popular use—nothing should ever be dropped in the ear except hot water. When the ear is throbbing with pain, the hot douche is the best means to employ for relief. In this condition any kind of a syringe is available, for there is not much probability of the sufferer throwing a stream forcible enough to increase his pain. Very hot water should be used. A quart of plain water as hot as can be endured should be injected, repeating it as often as is necessary—every five minutes, even.

If we happen to be beyond the reach of a physician, and the hot-water douche fails to relieve, leeching should be employed, remembering to apply the leech upon the little projection just in front of the ear, called the *tragus*. Do not ever put a poultice over the ear.

To secure rest at night and between the intervals of necessary douching, fill the auditory canal with hot water, cover the whole side of the head with a napkin wrung out in hot water, and tie a dry towel over the entire head.

Simple tenderness in front of the external ear or in the canal means either a pimple or a boil in the canal. In this condition also, hot douching and hot-water applications are the only safe remedies to employ at home. Medical advice must be sought early, to open the little abscess and allow the matter to escape.

Violent, throbbing, deep-seated earache means an abscess within the drum cavity of the ear; and this is a serious disease—often ruinous to the hearing, and even dangerous to life. The advice of a physician, preferably a specialist, is indispensable; and the above hints are not at all intended to supply his place, but merely to anticipate his arrival.

A FIFTH satellite of Jupiter was discovered by Prof. Barnard, of Lick Observatory, September 12th, and had been observed by him to October 17th on seven successive nights. It was also seen by Mr. Reed at Princeton, on October 10th, with a twenty-three-inch telescope. It is a star of the thirteenth magnitude. From three hundred micrometric observations by Prof. Barnard and the observation at Princeton, a period has been approximately deduced of eleven hours and fifty-seven minutes.

THE SYMMETRICAL DEVELOPMENT OF OUR YOUNG WOMEN.

By C. E. BREWSTER.

WHILE reading an earnest paper upon Conversational Immoralities, by Mrs. Amelia Barr (North American Review, April, 1890), I came across the following sentences: "There are bad people in the world, but young girls should never be near enough to them to be aware of the fact"; and "Women of whose lives young girls should, at least, seem to be innocent, are topics of conversation."

Now, while I am in full sympathy with the general tenor of this article, deploring as deeply as the author the increasing flippancy of speech of both old and young on this, the gravest question of the day, the sentences noted above, together with some others scattered throughout the article, move me to offer to your candid consideration a few pertinent facts aiming to prove that, where the reverse principle obtains, the highest good inevitably results to all who come within the radius of the pure young woman's intelligent interest and sympathy.

After comparing, for years, the general influence of the purely innocent woman with that of the pure and morally intelligent young woman of our day, I am so thoroughly convinced of the more abiding influence of the latter class that my earnestness impels me to try to show you a little more clearly the moral standpoint and resultant work of this unobtrusive but most potent factor in the refinement of society. Undoubtedly in this work, as in every other field of life, numberless opportunities arise for the sensational and supersentimental to gain (in the guise of philanthropy) the notoriety dear to their hearts. Not infrequently the novelty of the work appeals to many a young woman who, through immaturity and excess of zeal, brings upon herself condemnation where she sought elevation, failure where she sought success. But shall we therefore be discouraged? Shall we change our point of view simply because the few imprudent fall short of the good which they hoped to gain, because the few sensational pervert and distort the cause which we are trying to uplift? Shall the good actually accomplished by the greater number be tabooed because of the failure of the few?

A system which aims to conceal vice, rather than to suppress it by full knowledge, in reality fosters its existence. High ideals invariably beget correspondingly high realizations. For example, in many European cities it is considered not merely a daring breach of etiquette, but a social challenge, for a young woman to walk the streets unaccompanied by a protecting person.

As a consequence of this superficial convention, it becomes absolutely unsafe for respectable women to violate its code. Compare this with the state of things in our own country. Are our young women less pure or our young men less gallant where no such artificial system obtains? Is there not rather the greatest respect here for the young woman who treads fearlessly our streets, thinking no evil? But there are many bad people abroad. Shall the pure, therefore, be kept at home, their freedom fettered, their sphere of usefulness limited, because one third, perhaps, of those whom they pass go to and fro, abetting the indulgence of vulgarity and crime?

And if in the streets a pure woman commands respect because of her dignified bearing; if in the halls of higher education she walks apace with the thinkers of the day; if in the arts and sciences she is welcome as an able participant, why should she be barred from grappling with the greatest question of existence —the mystery of life and the abuses with which it is so thickly surrounded? Will she bring thither an insight less keen, a sympathy less spiritual, a judgment less temperate, a power less practical? And if she is to cope with the subject at all, is there any time when she will be in fuller power, in greater subtilty of influence, than in her developing womanhood? That she can reform our sensual world I do not claim; but that she is an intermediary, singularly well fitted for this work, I most earnestly believe.

Do not misunderstand me. I would not urge her going with the doctor on his rounds, nor the policeman on his raids. I would not drag her unneedfully to the haunts of shamelessness and resulting torment, but I would urge that she learn the principles of this, as of all life's lessons, in her early youth; that she be gravely and reverently led on to perceive her own high usefulness in perpetuating right views of this matter, so that with full knowledge she may face the sad life around her; that the veil be gradually moved aside—not kept tightly drawn till rent asunder at a time when the awakening must inevitably result in a revulsion of affection, a cynicism of spirit, and a hardness of heart, whose exceeding bitterness only those who have suffered can know.

I claim that the idea of usefulness, the quickening to the highest form of womanhood, combined with the early revelation of God's plan, will go further to disarm sensual thoughts than any artificial innocence, however well guarded.

Does any one question the purity of our young women physicians or our trained nurses? Does their knowledge of disease and its causes take from them that nicety of feeling with which they entered the profession? In many instances a sweet serious-

ness of manner, a shade more of dignity, perhaps, replaces the thoughtless buoyancy of unknowing youth; but the fine edges of inherent modesty are never dulled by scientific study pursued in the interest of bettering humanity.

A broad knowledge of the temptation to break the seventh commandment, surrounding our youth—a knowledge of the awful mental and physical suffering induced even in childhood by the violation of this commandment—not only places our young women in a position to be of the greatest practical aid to their brothers, but also gives them a sympathetic approach to that broad charity which Christ himself showed to the woman taken in adultery—that sad, sweet story which has come down to us through the centuries, bringing comfort to the hopeless and fallen, stimulating the compassion of the fortunate and pitiless. How many of us, I wonder, after being touched by the "sweet reasonableness" of this lesson, in actuality say to the contrite: "Neither do I condemn thee; go and sin no more"!

Ultra-innocence condemns too severely or condones too readily. It is incapable of inquiring into the general causes which produce from time to time certain disastrous individual effects. As a case in point, I know of a young woman brought up in the conventional manner in utter ignorance of the magnitude and nearness of this form of sin. Left, later, with the responsibility of bringing up two fatherless boys, shrinking from touching on these matters, she relied upon the refinements of home to be a sufficient protection against wrong living. In her happy confidence she said, "I would rather cut my throat than speak to my boys of these matters, or show them that I could think them untrustworthy here." I saw her later, when those boys, sent early into the world, unfortified as to its temptations, had fallen into sins whose shame must follow them all the rest of their days. Had she *known* of the over-prominence of this sin, would she not have worked as well as trusted?

On the other hand, I know well a young girl left motherless, with the care of three younger brothers. Instead of dexterously parrying the questions natural to young children, she took them to her heart, unfolding to them gradually the mysteries of their being, watching carefully over their reading and associations, meeting their perplexities at every point, and warning them of the strain of temptation to which all men must be sooner or later exposed; as they grew older, enlisting their sympathies in the work of helping others, getting them to meet her naturally on her own high plane, and finally gaining their hearty co-operation in this work. Do you think she would have been able to do this had she in her earlier days, before this responsibility came to her, "dwelt outside the current in which such subjects are spoken

of"? Do you think any other influence would have been as powerful in molding the lives of these young men?

It is very seldom, too, that young women can be kept in entire ignorance of the workings of this undercurrent. Nowadays the subject is much discussed; bits of information are dropped here and there by careless matrons; the sickening accounts of the infanticide of child-mothers (over the publication of the details of which accounts the daily press seems to claim an unquestioned prerogative)—all these things tend to depict, though in a fragmentary way, the workings of the other life. To assume, therefore, that our young women are ignorant of a state of things of whose existence they are perfectly well aware, is to put them at once upon the insecure basis of the dissembler. Is this simulated innocence of intrinsic value? Does it not rather dwarf growth and cripple usefulness? Unless early accustomed to viewing such matters from the truthful, helpful standpoint (and such standpoint *does* exist), our young girls become bitter and unsparing in judgment, sharers in that sweeping intolerance which half-knowledge always breeds.

Is there, I ask you in all fairness, any justice in exacting such a false social state? Here, as elsewhere, give our young women a chance to work. Do not bring them home with education "finished"—thoroughly equipped mentally, partially equipped physically, but utterly denuded of that intelligent moral accoutrement which is to make them well rounded in character, a power in their little world. Apply the strength now devoted to shielding their supposed ignorant innocence to the development of healthful views on a subject which must, sooner or later, confront every thinking woman. Many contend, I know, that our young girls are not strong enough to bear a comprehensive knowledge of this subject; that such knowledge, even though it may not rob them of their pure conceptions, at least causes them to become depressed and utterly cast down. But I think not, told with reverence, as a whole. They must face this knowledge eventually. Is it any less cruel to encourage the building up of disproportioned ideals which must ultimately be chipped away, piece by piece?

Let us grant, for the moment, that the conditions of society are now such that it *is* possible to keep young women completely ignorant of the moral laxity all around them. Let us admit, for the present, that it *is* possible for maturing persons to acquire broader views on all other topics and still retain their childishness of view in these matters. Do you think, therefore, that their influence, as is frequently claimed, will be stronger over the men with whom they come in contact? Do you think their misinformed minds can frame wise or trenchant judgments worthy of the respectful consideration of the men in their immediate circle?

That perfect innocence disarms impurity, even among those who have fallen far below the ordinary standards of virtue, I gladly admit. None but brutish men can resist the exquisite, oftentimes unconscious pleadings of things intrinsically beautiful—whether in the form of a mother's love, a hero's exaltation of spirit, a maiden's sweetness, or

> "The fair pure soul of a little child
> Opened wide to the light of day."

Such things must touch, for the time being, the hearts of the hardened; but, alas! they are so seldom far-reaching in effect or enduring in result. In very rare instances, in the cloistered nun, possibly in a jealously guarded daughter, does complete innocence now exist. And an opening flower can not go back again to the constricting clasp of its budding life without violating the law of its natural development. Shall we surround it with artificial barriers, thereby restraining and delaying its blooming, or shall we encourage it to unfold and thrive in the air in which God has placed it? No young woman, properly impressed with the noble dignity of her calling, equipped with wholesome views of life and fearless in purpose, can fail to command the respect and admiration of all who cross her path. A licentious or loose-lipped man would cower before her earnest eyes as certainly as before the appealing innocence of a child-woman, nor ever attempt to break down the barriers with which nobility of purpose always encircles our most womanly young women.

I am glad to see that many are now awakening to the necessity of abandoning the limitations of an old method which, while throwing a halo of romance around the barbarous and superficial chivalry of our knightly ancestry, in reality fostered the growth of a system of license whose many ramifications are to-day undermining the very foundations of our social structure. The latest work of our greatest English novelist portrays, as only his master-hand can portray, the need of woman's thorough comprehension of and co-operation in the treatment of this gravest moral problem of the age.

Just how a young woman may work in this field I can indicate merely in a general outline, which the tact, native ability, and earnest judgment of those interested will fill out as circumstances permit. For the proper carrying out of this work, integrity of purpose is the primal requisite. Eliminate that, and I unhesitatingly concede to the mediæval, convention-ridden methods the undisputed right of way.

In many of our cities our college-bred and working young women are at the head of little bands whose foremost aim is to gather in the children from the streets; for in this, as in every

reform, the root of the matter lies with the children. By the circulation of healthful books and papers, much is done to counteract the baleful influence of that vile printed matter which systematically inundates our public schools. Kindly, sympathetic talks are given, rarely bearing directly on these matters, but stimulating the indifferent to take advantage of all opportunities of self-improvement, and all making for the uplifting of a sin-burdened world. Care is taken, as these children grow older, to secure for them honest positions, to teach the unsuspecting to avoid those glittering pitfalls where the largeness of the salary offered is compensation in part only for service rendered—in reality is a premium upon loss of character and self-respect; to provide temporary homes for young women-immigrants landing helpless in strange cities, until suitable positions can be obtained for them; and, most important of all, care is taken to impregnate the working-girl element with the sense of responsibility devolving upon every woman as a person of influence, urging the dissemination of this thought throughout all their home work in some such ways as these. By urging the discipline of self-reliance and self-restraint, and the highest standard of purity, delicacy, and strength, equally on brothers and sisters; by discouraging the witnessing of certain popular but none the less indecent plays; by watching carefully over the reading of the younger members of the family, discountenancing the perusal of our so-called town papers by the boys as well as the girls (for no one can touch pitch and remain undefiled); by setting the example of avoiding the reading of details of popular divorce scandals; especially by guarding against that ubiquitous erotic literature which, masquerading in the attractive, fantastic garb of beautiful illustrations, claiming the prestige of realistic or classic origin, when divested of all its false trappings is, in all its hideousness, but a powerful excitant, stimulating the prurient imagination of the inexperienced, thereby starting many a child on the treacherous path down which it is so pitifully easy for the untaught to slip, and whose starting-point it is all but impossible to regain. This form of reading-matter is the most successful of all the recruiting officers from the vast army of the shameless.

To carry this work on helpfully and practically, to gain a positive algebraic sum from these many efforts, must not our young women "know of the existence" of fallen men and women? Could they increase their power, here or in their home-influence, by "seeming to be ignorant of the existence of such people"?

Ah! these young women are to be the mothers of our race: shall we not arm them with the knowledge wherewith to breast the future? Will not this knowledge in the average intelligent young woman, combined with the unsullied heart which is her

birthright, make her a more worthy co-operator with her husband; a stronger spiritual sympathizer; one who will not flinch when confronted with the privilege of making noble women of her daughters, of saving her sons from falling victims to the sin which is dragging down to ruin so many of our finest young men?

"The height of the pinnacle," says Emerson, "depends upon the breadth of the base." Give, then, to our young women this broad basis of knowledge. as you wish the height attainable to be proportionate and exalted.

PROTECTIVE INOCULATION FOR CHOLERA.

By S. T. ARMSTRONG, M. D., Ph. D.

IT would be difficult to say where the idea first originated of the possibility of artificially producing occult changes in the organism of a healthy individual, so that, if exposed to a contagious or an infectious disease, there would be an acquired resistance that would prevent the development of such a disease. Tradition states that, in the case of small-pox, the custom existed in South Wales of rubbing matter from the pustules of a small-pox patient on the skin of a healthy person's arm, in order to protect the latter individual from acquiring that malady; and, for a similar purpose, it was the custom in the Scottish Highlands to wind about the wrists of children worsted threads that had been moistened with such matter. Inoculation of healthy persons with variolous matter had long been practiced in Oriental countries when Lady Mary Wortley Montagu introduced it into England. And as recently as our civil war this procedure has been employed, because the usually mild attack of small-pox following the inoculation is less dangerous than the ordinarily acquired form of that disease.

The discovery of the protection afforded by vaccination suggested new working theories; for it was as remarkable that the contagious principle of small-pox should undergo some modification in the human system as it was that it was decidedly modified in the cow. It has been demonstrated by many experimenters that, in a calf that has not had cow-pox, inoculation of small-pox virus will cause that disease; and, furthermore, that matter from the eruption on the calf's udder will, if inoculated in an unvaccinated person, produce the well-known phenomena of vaccinia. Science, accordingly, learned two facts from this: that the virus of a disease may be diminished, or attenuated, in its development in an animal organism other than that in which it found its most poisonous growth; and that this attenuated virus, introduced into

the organism of an individual susceptible to the influence of the original disease, protected that individual by conferring an artificial immunity.

To these known facts regarding small-pox was added that knowledge gained during years of observation by both medical and lay men, that one attack of a contagious or infectious disease protected the individual, as a rule, from a subsequent attack if exposed thereto in later years. Little or no perceptible alteration existed in the human organism, and yet it had acquired some singular quality that enabled it to resist the infection of that disease if ever again exposed thereto.

It is to-day believed by excellent authorities that the processes by which this immunity is obtained vary as widely as do the processes of disease themselves. Each of these infectious diseases produces in the blood certain poisonous substances; and as man can be, so to speak, familiarized with a poisonous drug by the administration of doses that gradually increase from one that is harmless to one that ordinarily would be at once fatal, so there is probably a similar Mithridatic transformation in the character of the fluids of the body that have once met and conquered the toxic principle of an infectious or contagious disease.

Working on this hypothesis scientists have been experimenting with the introduction into the animal organism of the poisonous substances called toxines, toxalbumins, leucomaïnes, or ptomaïnes, that are produced by the micro-organisms of the various diseases, in order to determine the possibility of preventing the susceptibility for acquiring these diseases.

The discovery of a method that would protect an individual from cholera would be of great usefulness. For in India, the home of that disease, the average annual mortality therefrom in the cities is 3·32, and in the country 1·52 per 1,000 living. The army statistics show that 2·49 per cent of the European soldiers are admitted to the hospital for cholera, while only 0·95 per cent of the native soldiers are admitted for the disease; but the mortality, 33·69 per cent for the former, 35·5 per cent for the latter, is almost equal. In the various epidemic manifestations of cholera in various parts of the world the mortality has often exceeded 50 per cent of those attacked. In 1884 and 1885 cholera was epidemic in southern Europe, and in Spain in the latter year the official report states that there were almost one hundred and twenty thousand deaths. There were fifty-one persons affected in each thousand living, and the mortality was 36 per cent. These statistics stimulated investigators to attempt to solve the problem of affording immunity to cholera.

In March of 1885 Dr. J. Ferran, living in a small town in Catalonia, sent a communication to the French Academy of Sci-

ences in which he described some experiments he had made with the specific organism of cholera, the comma bacillus, Koch's comma bacillus, the cholera spirillum, or the cholera vibrio, as it has been variously termed.

By experiment it had been learned that the cholera spirillum, like many other micro-organisms, would develop plentifully in certain nutritive substances, such as a very rich beef broth or jelly if kept at a certain temperature. Such an artificial propagation of a micro-organism is called "a culture" of that organism. Ferran found that the maximum virulence of the cholera spirillum was obtained in a culture of rich, slightly alkaline bouillon, and that from thirty to sixty drops of this culture would kill a guinea-pig, if inoculated under the animal's skin; but, if a smaller dose was inoculated, a local inflammation followed that might slough though the ulceration would heal spontaneously without forming pus; and this animal would not be subsequently affected by the injection of a quantity of the culture of the cholera spirillum that would rapidly prove fatal in an unprotected animal.

Ferran reasoned that if such a result could be obtained in the organism of a lower animal, why could it not be secured in the highest animal? Accordingly, he injected hypodermically in man, fifteen drops of his virulent culture: a hot, painful tumor, with local fever, and *malaise* followed, but without choleraic discharges from the bowels; and these symptoms disappeared in twenty-four hours. If a similar quantity was reinjected in the man a week later no general and few local symptoms followed. He therefore considered that by these injections of graduated doses he could arouse in each person's system that resistance to the disease that has been heretofore referred to. He did not believe that the cholera spirillum multiplied in the cellular tissue that is beneath the skin, but that it produced in the tumor formed at the point of inoculation a rapidly diffusible toxine that exercised some influence upon the nervous centers. The dangers of an attack of, and death from, cholera begin to disappear five days after the first inoculation, and each successive inoculation increases the guarantee of immunity; three inoculations, each of thirty drops of the bouillon culture, at intervals of five days, produced a profound immunity.

He continued his experiments, and in 1886 sent another memoir to the French Academy of Sciences, wherein he stated that cultures of the comma spirillum in which the living organism had been destroyed by a high temperature, would, when inoculated, confer a tolerance that successfully resisted the effects of the living spirillum. He furthermore stated that an active principle was generated by the spirillum, that could be isolated by certain

familiar chemical methods, and that conferred the power of resisting the living micro-organism.

During the epidemic in Spain, Ferran's inoculations were practiced in more than thirty thousand persons. In the province of Valencia there were 62·33 cases per thousand of population, and 31·11 per thousand died of cholera. Where inoculation was generally practiced the cholera affected 76·95 per thousand, with a mortality of 33·58, of the total uninoculated; while among the inoculated 12·69 per thousand were attacked, and only 3·41 per thousand died. In other words, in the latter class 6·06 times fewer people were attacked, with a mortality 9·84 times less than that of the uninoculated.

Ferran's methods were investigated by commissions from several of the European scientific societies; and by several, notably that from France, he was condemned for having made claims that could not be demonstrated.

In 1888 Dr. Gamaleia published the results of experiments he had made with the cholera spirillum. He found that the cultures of this organism, as obtained from the human body, lose their virulence in the laboratory. In order to restore this virulence, and possibly to enhance it, Dr. Gamaleia first inoculated a guinea-pig with the cholera spirillum, and when the disease was apparent in that animal made an inoculation from it into a carrier-pigeon. This was on the principle employed by Pasteur to increase or attenuate the virus of chicken-cholera, rouget, anthrax, and rabies by inoculating different animals with the respective virus of those diseases. So toxic does the cholera spirillum become in the pigeon, that a few drops of its blood rapidly kill an animal susceptible to cholera. He also found that in a sterilized culture of the spirillum there was a principle that, administered in non-toxic doses to an animal, would afford subsequent protection from cholera. The phenomena produced by these inoculations were similar to those observed by Ferran in his own experiments, though no inoculations were made in man by Gamaleia. G. Klemperer has reported this year experiments that verify those made by Ferran and Gamaleia. He discovered that a guinea-pig could be protected against cholera by inoculating it with the serum of the blood of a rabbit that had been protected by inoculation of mild cultures of the spirillum; and in one rabbit that had been rendered immune to pneumonia as well as to cholera, its serum afforded protection from cholera to guinea-pigs, and from pneumonia to mice. He considered that these results corresponded with the immunity observed in human beings after an attack of Asiatic cholera.

During this year Haffkine has reported to the Paris Biological Society experiments that he has made with the spirillum.

One of the objections that has been made regarding the acceptance of this organism as the sole cause of cholera has been the difficulty of reproducing in animals, by injections of the spirillum, a disease that generally resembled human cholera. Haffkine adopted the ingenious plan of using diluted serum obtained from rabbits as the medium for the development of the spirillum, and transferring a few drops from this to a less diluted serum, and so on until the micro-organism lived in the undiluted serum. If the spirillum thus acclimatized, so to speak, be injected into the blood-vessels of a healthy rabbit, the animal will die with all the symptoms of cholera; this serum might be called a virulent culture. By passing an ordinary bouillon culture of the spirillum through a series of guinea-pigs he could also obtain a virulent culture that rapidly killed if injected into the abdominal cavity, but that, when injected under the skin, produces phenomena similar to those described by Ferran, and results, as the latter stated, in rendering the animal immune against inoculation with cholera in any strength whatever. Rabbits and pigeons were rendered immune in the same way. These results induced Haffkine to try the inoculations on himself and seven other persons; the phenomena observed in each of these individuals were similar to those reported by Ferran, and a second inoculation made after an interval of seven or eight days produced far less general and local disturbance than the first. While differing slightly in the methods employed, all these later experimenters, it may be seen, have confirmed Ferran's original report, although none of them mentions his name or the priority of his discovery.

What is the value of these inoculations? This may in part be answered by the question, What is the harm? All observers concur in stating that in animals, as well as in man, the inoculations, made in moderate doses, are harmless beyond producing a slight local irritation and temporary *malaise*. And any one who has been subjected to the inoculations can easily determine at any future period whether he is then protected, by receiving another inoculation; just as a later determines the protection of the individual by an earlier vaccination.

It is necessarily conceded that the factors that enter into the question of natural are not those of artificial infection. But it is necessary to recall the facts stated in the first portion of this paper; and it is seen that there are good grounds for believing that immunity against natural infection is correlated with immunity against artificial infection. There may be no exact and absolute demonstration of this fact, for no vaccinated person willingly associates with a small-pox patient, or has himself inoculated with matter from a small-pox sore, in order to determine his immunity toward that disease. The vital statistics of this cen-

tury answer the question regarding the utility of vaccination. Whether those of the coming century will answer that regarding the utility of inoculation as a preventive not only of cholera, but of other infectious or contagious diseases, remains to be decided.

FALLACIES OF MODERN ECONOMISTS.*

By ARTHUR KITSON.

IN matters scientific as well as religious a conflict of opinion among professors is apt to produce skepticism among scholars. Nothing tends to discredit the teachings of a system more than want of harmony among its exponents. For such discordance is an acknowledgment of doubt and uncertainty, of failure to discover the truth. Before any branch of human inquiry can properly be dignified with the name of science, there must be some sort of general recognition of at least the fundamental principles upon which it is built—some general agreement as to what laws govern the phenomena with which it deals.

Not until conflicting theories and opinions have been settled and a uniform classification arrived at, can we be said to have entered the realm of exact science. Scientific exactness is, in fact, marked by the absence of intelligent criticism. Like religion, science has had and still has its battle-grounds, where scientist wars on scientist. Such disputes, however, are usually confined to mere speculations, undemonstrable theories, or undeveloped fields of inquiry. When once the speculation ripens into a demonstrable truth, all contention ceases. For the aim of science is the discovery of truth. Of modern sciences, none stands more discredited by the average reader than the so-called science of economics. The cause of this becomes apparent when we consider the contradictory nature of the theories taught by modern economists, the utterly discordant answers given to social problems, and the extreme divergence of the paths proposed for reaching social happiness. For instance, we are informed by one economist that the cause of all or nearly all the crime and misery surrounding us is due to the system of private ownership in land; another attributes it to the profit system, another to industrial warfare engendered by competition, another to privileges granted by governments to specially favored classes and individuals, another to the drink traffic, and so on. And the remedies prescribed are equally varied. One school directs us to nationalize

* Abstract of a lecture delivered before Friendship Liberal League, Philadelphia, June 10, 1892.

the land, another to confine taxation to land, another to nationalize all the instruments and means of production, another prescribes a system of co-operation. One favors the enlargement of the powers and scope of government, and another insists on the annihilation of all governments. Small wonder, therefore, that the reader, who has not time to penetrate far below the surface, should lack faith in the teachings of a system whose doctors so thoroughly disagree.

An interesting and somewhat amusing book, entitled The Why I Ams, published by the Twentieth Century Publication Company, comprises a collection of short essays by the representatives of most of the modern economic societies, in which the writers give their reasons for the faith that is within them. Each writer is confident that the school to which he belongs possesses the true solution to the riddle of the social sphinx, and regards his scheme for social redemption as founded on "fundamental scientific principles." Let us examine some of these "fundamental principles" upon which these societies are founded. One of the "fundamental principles" underlying Progress and Poverty is, that the fund out of which wages are paid is created by the wage-earner. It follows that, if this be so, the doctrine that wages are advanced by capital falls to the ground. Mr. George proceeds to test his theory by induction. The illustrations he gives are of two kinds. One class applies to isolated settlements and the other to modern society. The one class apparently favors his theory, the other, however, is decidedly against him. For example, he instances conditions where men are employed in picking berries, gathering eggs, catching whales, etc. In these cases he says it is customary to pay those employed in such occupations by giving them a certain proportion of the things they have brought. In certain gold-fields it has been customary to pay the miner for his labor by giving him a certain percentage of the gold he has mined. All this seems clear enough, and, if the world's industries were confined to those above cited, Mr. George's principle would undoubtedly be sustained. But when he goes on to apply it to the modern factory, ship-yard, and those industries which form the vast majority of human occupations, the facts clearly disprove his assertions.

Mr. George says: "Bring the question to the test of facts. Take, for instance, an employing manufacturer who is engaged in turning raw material into finished products—cotton into cloth, iron into hardware, leather into boots, and so on—as may be, and who pays his hands, as is generally the case, once a week. Make an exact inventory of his capital on Monday morning before the beginning of work, and it will consist of his buildings, machinery, raw materials, money on hand, and finished products in stock. Suppose, for the sake of simplicity, that he neither buys nor sells

during the week, and after work has stopped and he has paid his hands on Saturday night take a new inventory of his capital. The item of money will be less, for it has been paid out in wages; there will be less raw material, less coal, etc., and a proper deduction must be made from the value of the buildings and machinery for the week's wear and tear. But if he is doing a remunerative business, *which must on the average be the case,* the item of finished products will be so much greater as to compensate for all these deficiencies, and show in the summing up an increase of capital. Manifestly, then, the value he paid his hands in wages was not drawn from his capital, etc." (Progress and Poverty, page 53.) You will observe the qualification allowed in the sentence, "if he is doing a remunerative business, which must on the average be the case"—a qualification that admits the incorrectness of Mr. George's theory applied to *unremunerative* businesses. Non-paying industries are not rare. One statistician tells us that from ninety to ninety-five per cent of all those who embark in business in this country—the majority of whom are employers of labor and pay out wages—fail. It seems extraordinary that an able thinker like Mr. George could believe he had discovered a general law which admittedly fails in so many instances. In applying the theory to the case of the Great Eastern steamship, Mr. George chooses a most unfortunate instance. He says: "Here is a machinist or boiler-maker working on the keel plates of the Great Eastern; is he not also just as clearly creating value-making capital?" Not necessarily. It depends entirely upon whether the steamship proves a success. Events since showed that she was a gigantic failure. She never earned more than a mere percentage of her cost, and was finally sold for old junk. The greater part of the wages paid to those workmen was drawn directly out of the pockets of the English capitalists, and little, if any, of it was ever returned.

The facts in all those instances selected by Mr. George simply show that under certain circumstances the wage-earner brings to his employer the fund out of which his wages are paid, and under others (probably the vastly greater number) the wages are paid directly out of the fund provided by the employer. The conclusion is, therefore, that while Mr. George has shown exceptions to the economic theory that wages are drawn from capital, he has certainly failed to establish the truth of his own.

In the broad philosophical sense, capital is always the mother of labor,* which simply means that before labor is possible there must be a stock or reserve fund of power—a certain potential force—from which labor draws its sustenance, whether it be in the

* See Prof. Huxley's essay, Capital, the Mother of Labor.

shape of money of the realm or that for which it is exchangeable —viz., food products—or the capital may take the form of ready manufactured brain, blood, nerves, and muscles.

No labor is possible without the power to work, and the power to work must be stored up in the human frame, and a sufficient supply of protoplasm housed to maintain human energy, in order to make labor possible. What else is this than capital—"wealth devoted to the production of more wealth"?

The definition of labor given by Mr. George "includes all human exertion in the production of wealth." Supposing wage-workers were limited to this definition as the standard for gauging the value of their services, what would become of those employed in unremunerative industries or in those of an experimental nature? It would mean that the time they had spent in the manufacture or construction of anything which on completion was found to be unsuccessful, could not be classed as *labor*, and for which they could make no claim—a decision which Mr. George would scarcely be prepared to allow as just.

I must now call your attention to another fallacy which is too gross to overlook, especially as it occurs in other schools of reform outside of the single-tax party. It is that of ascertaining some law applicable to a rude or elementary society, such as Robinson Crusoe and his man Friday on a desert island, and applying the same law to society in an advanced state.

Reasoning by analogy is often a very dangerous proceeding, especially when used by the unskillful. In order to show that capital is really a very useless thing and quite unessential to life, Mr. George cites instances where a number of men begin life on an island and commence without capital by picking berries, catching fish, and killing game. This may be all true in a small community, providing there happen to be the necessary game and fish and berries, the possible absence of which Mr. George overlooks. But where can a city like New York provide itself with sufficient game, fish, and berries to support life without the use of capital? Mr. George tells us that "the fundamental truth, that in all economic reasoning must be firmly grasped and never let go, is, that all society in its most highly developed forms is but an elaboration of society in its rudest beginnings, and that principles obvious in the simple relations of men are merely disguised, and not abrogated or reversed, by the more intricate relations that result from the division of labor and the use of complex tools and methods." (Progress and Poverty, page 29.) For a complete refutation of this "fundamental truth" we have an argument furnished by Mr. George himself. In his efforts to demolish the Malthusian theory, he says in Chapter II of Book II: "The globe may be surveyed and history may be reviewed in vain for any

instance of a considerable country in which poverty and want can be fairly attributed to the pressure of an increasing population." You will notice how he qualifies "country" by the word "considerable." And in a foot-note he explains the meaning of the words "considerable country," by stating that there may be small islands, such as Pitcairn's, which may seem to offer examples in point. Now, if the "fundamental truth to be grasped and never let go" is, that laws applicable to a small and crude society hold equally "in its most highly developed forms," why is not the law of the pressure of population against subsistence which reigns in Pitcairn's and other small islands applicable likewise to societies everywhere? And if not, why propound such a theory?

This same style of argument occurs likewise among socialistic and anarchistic writers, and is one of the props necessary to sustain their conclusions. For example, the socialist witnessing that, with the formation of trusts, the cheapening and facilitating of production goes on wherever the combination and co-operation of capital takes place, argues that production will reach its limit of perfection by the appropriation of *all* capital and of *all* the means of production by the state—an error disproved every day by the inability of the people collectively, through their representatives, to even pave their own streets, manufacture an average quality of gas, or supply themselves with decent water.

The anarchists, observing that many laws work injustice and wrong to thousands, and that great advantages have been brought about by the repeal of them, reason that the summit of human happiness will be attained by the repeal of *all* laws and the abolition of *all* government, strangely forgetting that mankind have found both government and law essential to the organization and stability of society, forgetting also that well-merited punishment is very generally meted out to criminals by law. It does not follow that, because within certain limits the benefits of a given system are found to vary in a direct ratio with its extent of application, this same ratio will be continued *ad infinitum*. "Trees do not grow up to the skies."

The man who gradually reduced his donkey's daily rations in hopes of eventually accustoming him to do without food, succeeded in accomplishing his purpose. But the donkey died. May I ask my anarchist friends if they have contemplated under their scheme the possibility of the death of their donkey—society?*

State socialism and philosophical anarchism are generally supposed to be antipodal to each other, the one achieving its results by the welding of men into a rigid whole, the other dividing society into its units.

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* Ruskin, Government and Co-operation, p. 64.

Viewing them from a philosophical standpoint, I should say the one lacks mobility, the other cohesion. The one has a single eye to the freedom of the individual and trusts to luck as to the destiny of society; the other sees only the social union and equality of all, and trusts to chance to take care of the freedom of the individual.

I do not want to fall into the vicious error of our *a priori* friends who think they can predict exactly the results that will flow from their social prescriptions. But if human experience is to be taken for anything, neither socialism nor anarchism are destined to work out the way their advocates would have us believe. Economics is not an exact science. We have not yet arrived at that point where we can predict events. The fact that among economists there are so many contradictions is evidence of the want of a scientific basis for their theories. One cause of very much of the disagreement among modern economists is the misapplication of the law of induction. Inductive reasoning is safe only when conducted on proper lines and carried out to the fullest extent, otherwise it is, as Bacon says, "a weak and useless thing." The interminable contention between the schools of free trade and protection (or "aggression," as Herbert Spencer calls the latter) is largely due to this kind of imperfect reasoning. "Your theories are all very fine," exclaims the protectionist, "but we prove our case by facts, cold facts." And when you carefully examine his collection of instances, you find them to consist of a specially assorted lot of isolated cases that apparently favor his theory, all others being carefully avoided or rejected. For example, on the question of wages. We are told by high political authorities that high wages are a necessary consequence of high protection, while free trade produces low wages. Now for the proof. In the United States, a protective country, wages are higher than in free-trade England! The free-trader naturally asks why the protectionist confines his instances to just these two countries. If inductive reasoning is to be applied, why not collect every possible instance? The results would be as follows: Russia, Germany, Austria, France, Spain, and Italy, are all "protected" countries—some highly "protected." Wages in each of these are far lower than in Great Britain.

Again, in the free-trade colony of New South Wales wages have been, and I understand are still, higher than in this country, and in parts of Africa where no tariff exists wages are extremely high. On the other hand, in China, where "protection" has existed longer than in any other country, and where it has reached its highest stage of consistency, wages are lower than anywhere else on the face of the globe. And yet once more: "Cold facts" show that the standard of living and rate of wages among the working

classes in England have been and are much higher under free trade than they ever were under "protection." Facts are unquestionably worthy of attention, but no general law can possibly be established by any such collection of isolated cases as that commonly made by the "protectionist." The same fallacious reasoning is accountable for most of the sophisms that at present becloud the minds of the disciples of this school.*

Another cause of very much of the difference of opinion that exists among economic writers and reformers lies in the indefiniteness of the terms employed. If we compare the definitions of the writers of different schools, we shall see what a hopeless confusion reigns. Land, wealth, capital, labor, wages, interest, rent, and profit all mean something different to different schools. And yet we are told by each school that it is founded upon science, that it has a scientific basis. I know of nothing more unscientific than a confusion of terms. "Land is wealth," says one. "Land is capital," says another. "Land has no value," says a third; and so on, until you begin to wonder what sort of a thing land really is. Until an agreement on terms is reached, there can be little hope of harmony in teaching, or a discovery of truth. This discord, however, shows us how difficult a problem these gentlemen are attempting to solve, they "who rush in where angels fear to tread." To my mind, it will be a long time before political economy arrives at that point where it can be dignified by the name of science—to that "great and final object of all science, predicting events," as Buckle calls it. At present we have much *a priori* speculation and little else. Every reformer thinks he *knows* exactly what his scheme will bring forth—how it will operate—"how sorrow and sighing will flee away, and tears be wiped away from all eyes." But one can not help inquiring how these gentlemen *know* that such and such results must follow the adoption of their plans. History is strewn with the wrecks of numerous enterprises founded on similar reforms, conceived, planned, and superintended by exceedingly intelligent men, such as Fourier and Robert Owen, John Ruskin, and others.

The fact is, that what we call society is such a marvelously complex machine, or animal, that its scientific treatment—analysis, synthesis, etc.—is at present utterly impossible. In fact, our treatment of society as a whole, as a huge machine, is both misleading and irrational. Society is not so much one machine as a multitude of small machines, each acted on by various forces, the resultant of which is an unknown and indeterminate quantity. These forces propel the machines in various directions—some an-

* I have already dealt at length with this fallacious mode of reasoning in The Popular Science Monthly for November, 1890, entitled Logic of Free Trade and Protection.

tagonistic to others, impinging on each other, rebounding, expending force uselessly, with endless friction, noise, and breakage. How difficult it must be to form any intelligent classification, a moment's thought must convince us. Here is a man whose motive power is love of money, who shrinks from nothing, dares all, endures all, to satisfy this passion. There is one whose sympathies are strong, who spends and is spent for others, philanthropically. Another is driven by conceit, by love of fame; another by fine clothes, and another by love of power; another sacrifices all for knowledge, and so on. All these and thousands of other types, possessing not one, but many passions in varied amounts, and probably no two individuals identical, go to make up this unit which we call society. And then we divide them into laborers and capitalists, and prescribe hard and fast rules by which we assume the conduct of each class is controlled, and on these assumptions we build a science! Such is the science of political economy!

Take, for instance, the term "laborer." To whom does it refer? "To the producer," says our economist. Producers of what? "Of wealth." And what is wealth? "Good things," says one. "Useful things," says another. And what is a useful thing? "That which in its operation conduces to human welfare or pleasure." So that the laborer is an animal or a machine, the product of which is finally resolved into terms of human pleasure. What man is there who is not a laborer? Who does not produce pleasure to others as well as to himself? Why, the very act of living requires an expenditure of labor. And from this sheer act of existence up to the hardest kind of manual labor there is a gradual *crescendo*, a line of unbroken continuity.

How, then, can you draw a complete dividing line separating producers from non-producers? Surely not at digging the earth, nor even at manual labor. Try as you will, I fail to see where a dividing line comes, save only between the dead and the living. If, for instance, you admit the school-teacher, the actor, the musician, the painter, the confectioner, or the milliner, as laborers, why should you omit the friend, the husband, the child? For the basis of the classification of the first is the satisfaction of human desires. The latter class likewise satisfy human desires!*

Again, if we attempt to draw a line separating capitalists from laborers, we are met with the same difficulty. For, as capital is the mother of labor, every laborer must of necessity be a capitalist, and from the man who possesses simply physical health, strength, and reasoning faculties, with clothes enough to cover

* "There is no wealth but life; life including all its powers of love, of joy, and of admiration."—RUSKIN.

him, we rise by insensible gradations, by an unbroken line, to the millionaire who controls thousands of men.

A characteristic of one class of economists is their fierce denunciation of the profit system. "Profit," they say, "is robbery." They contend that if a manufacturer supply the machinery for the manufacture of commodities, an amount set apart sufficient to replace the machinery when it shall have worn out, and no more, is a just return for its use, and all over and above this is theft. Now, the question at once arises, What does the laborer do more than the machine, that he should expect more than the equivalent for the quantity of brain-matter, nerve-tissue, and muscle expended by him in his labor? In other words, if he be allowed sufficient food, clothing, and shelter to maintain him in a healthy condition so long as he gives his entire labor time, is not justice satisfied? Is not this a *quid pro quo?* Why should one class of labor be allowed a larger return for its produce than another, even though this be made of brass and iron and steel instead of blood and bone and brains? Still further, if the producer is to receive the full reward of his labor, why should not the machine that produces ten times the quantity that the laborer produces receive ten times the reward? Setting out with the term "labor" as "that which produces wealth," a term that likewise defines the function of machinery, you will see the results to which we are reasonably drawn. You will understand that your economist does not claim that the question of affection or of moral obligation should interfere with the logical conclusions at which he arrives. The grand science of economics does not recognize human sympathies.

If we distinguish between labor and machinery by defining the former as *human* exertion applied to production, we gain nothing, since political economy gives no reason *why* a difference should be made in the treatment of the two. The distinction ordinarily observed is to make labor the grand motive power of production, and machinery the mere agency for rendering labor more productive. This is not a clear nor a just distinction. For the principal function of machinery is to *displace* the laborer rather than to make his labor more productive.

Take an illustration or two. The man who, in place of using a rough knife to cut down the branches of trees, invented a saw, made something which caused his labor to be more productive—i. e., a given quantity of the same kind of his energy produced larger useful results than before. So the invention of the file, by enabling him to sharpen his saw, made his labor still further productive than if he had to use a blunt one. Tools, especially, fulfill this particular function of making labor—the same kind of energy—more productive.

Now, take the case of machinery. In place of the old-fashioned wells, with the bucket and rope—the primitive method of drawing water—you have the pumps, boilers, steam engines, and reservoirs of a modern water-works. Similarly, instead of the ancient style of propelling boats by means of oars and paddles, you have the modern steam vessels. To say that machinery in these and endless other examples is "that which renders labor more productive or more efficient" is mere folly. Human labor is here *wholly displaced*, and the principal human exertion employed is that of a totally different nature, being transferred from the muscle to the mind. Instead of ten, twenty, forty, or a limitless number of human arms pulling on as many oars, you have one or two employed in watching indicators, water gauges, and other similar contrivances. And the principal manual exertion is that required in turning a valve. Even in the case of firing boilers, the recent inventions in fuel tend to abolish human exertion. The tendency of human ingenuity in the field of production is to wholly and totally *abolish* human labor. Machinery, therefore, becomes qualitatively the equivalent of labor, inasmuch as it supersedes it—does what men's muscles do, only more economically and efficiently. Speaking logically, we have no grounds for making any distinction in economics between labor and that which possesses precisely similar functions, viz., machinery. And so long as this is the case we have no reason, from an economical standpoint, to observe the slightest difference in our treatment of the results of each. In a division of the proceeds of capital and labor, dividing them in the ratio of the amount contributed by each, how small a share belongs equitably to labor, and how large an amount to machinery, a moment's thought will make clear.

Adam Smith stated that in his time ten men could make 48,000 needles per day. This was prior to the invention of the needle machine. This machine Karl Marx mentions as making 145,000 per day of eleven hours, and that "one woman or girl superintended four such machines, which produced near upon 600,000 needles in a day and upward of 3,000,000 in a week." It would be absurd to speak of this machinery making labor *more productive*. It has entirely displaced it, and the only human exertion required is that of the girl's superintendence, which is of a vastly different character from that of the men who made needles by hand, and is really of a lower order of skill and intelligence. Dividing the gross products in ratio of the two factors employed, we find that one girl and four machines are the equivalent to twelve and a half men. If we allow the girl's labor as equal to half a man's, we have four needle machines equal to twelve men, or one machine equal to three men. It is unnecessary to multiply examples. The tendency in mechanical inventions is to

totally displace labor, both manual and mental. Each improvement in machinery tends to make it more and more automatic, self-governing, and the least intelligent person is usually found capable of running some kind of machinery.

The socialist admits that the vast production of wealth which has characterized the past century is due to labor-saving machinery. But he claims that this machinery is in itself the product of labor, which it unquestionably is. He argues, however, that the inventor has no right to the exclusive enjoyment of his ideas.

If inventions were the creation of all the members of a society equally, each would be entitled to his share of the product equally, and our economist would be right. But such is not the case. Supposing in a community a number of men are engaged in weaving a certain kind of fabric by hand. After a time, by careful thought, study, and years of experimenting during his evenings, one of them succeeds in constructing a machine capable of weaving in a day as much of the fabric as ten men can do in the same time; and, supposing the amount of manual power to operate this machine is the exact amount expended by one man in his ordinary day's task, then this man and his machine perform the work of ten men in an equal time, and if he only work it one hour he has produced what previously occupied him one day. He may therefore work one hour per day and get the same return as before, or by working one day get the produce of ten men. Supposing he offers to one of the other men the privilege of working this machine in his place, which requires no greater expenditure of labor on this man's part than the work he is engaged on, and the man accepts. The inventor of the machine may offer him the produce of two days' labor as an incentive to accept employment from him. The inventor then becomes a capitalist, an employer, and gets his ten days' produce, paying his employee two days, and retaining eight himself, for which he himself does nothing. Practically his work has ceased after inventing, designing, and constructing the machine. Is it an act of injustice for him to claim the product of the machine which is his invention? And if he build one machine and employ one man, may he not build two and employ two men, and carry this on until his machines supply the entire demand? And may he not transfer his interest, or part of an interest, to another, and another, until you have a number of idle men living off the produce of the labor of the machines and employees? There is in this nothing unjust from an economical standpoint, for this man has taken nothing which did not originate with him.

But, says the reformer, were it not for the protection afforded the inventor by society, the privilege he artificially enjoys, these employees would build their own machines and each man be his

own master. This, however, does not necessarily follow, for it assumes that each man would have both the ability and willingness to construct a machine. But suppose they did, would this be just? Is it any the less robbery for a man to steal another's brain produce—ideas—than to steal the products of his hands, commodities? Would the infringer not be obtaining something which he did not produce? If justice consists in giving to each man the product of his labor, and robbery consists in a man taking that which another produces, would those who copied the inventor's machine be any the less robbers?

If we are to accept the basis laid down by economists by which "rights" are determined, I do not see how you can escape from the system known as profits. You say this system is degrading and unjust. Granted. But, on the grounds that Mr. George and others have selected for determining what is right and what wrong, I can not see any escape from the "right" of profits. You may say it is inexpedient for society to continue it. That is a different matter entirely, and it may be for the welfare of society to abolish profit, rent, and interest. But, in the light of the "science of selfishness," there is nothing which shows it to be unjust, or those accepting such return as being robbers.

I have endeavored to select at random a few of the fallacies underlying many, if not all, of the modern schools of reform, that teach that the road to social bliss is by the science of economics. My contention is that much of the present evils which afflict society is due to too great a prevalence of *Nature's* laws, and to too little practice of the *moral* law. So long as reformers endeavor to work out their respective systems by an appeal to the so-called science of political economy, and persistently ignore the moral phase of the question, so long must society wait in vain for the realization of its dreams. The final teaching of economics would show that it is far more conducive to national wealth and prosperity to stimulate the production of machinery than of men!

This grand science of economy has surely had a wonderful effect. It has cheapened commodities and cheapened men, and men are now cheaper than the commodities! Since it has determined to work the problem of society out on this basis of the laws of supply and demand, and has taught man to buy in the cheapest and sell in the dearest markets, it has brought humanity itself to the same basis, and men find themselves immeshed in a web of their own weaving. The law of supply and demand now governs them, and men are bought and sold like the commodities themselves.

Is there, then, no solution to the great social problem of poverty? Can nothing be done to save humanity from itself? "It is

all very well to criticise the schemes of others," may be said, "but have you anything better to offer?"

I confess I have no particular scheme of reform to offer, nor any patent method by which society can lift itself up by its boot-straps; but, in my humble judgment, most of the modern reformers are overlooking the one thing which is really the parent of much of the misery they desire to exterminate. And that cause is the parents themselves. Go into the slums and alleys where most of this poverty and misery abound, and you find them teeming with children—ragged, half-starved, hungry-eyed, semi-diseased children. What is the use of dredging a pool if, for every bucket of dirt you take out, another dumps in a wagon-load? Why, if that part of society to which this state of existence is common did not make themselves so cheap, they need be in no such condition. When there is a superabundant crop of apples, you will find the orchard strewn with them, rotting from neglect. The best are taken, and the poor ones are trodden under foot. And when these bountiful harvests of children continue with such exasperating regularity, you may expect to see the worst part of humanity cast out and trodden under foot, literally left to rot as useless, so long as society is as it is. Why should men make themselves so cheap? If ever the doctrine of "restriction" needed enforcement, if ever there was a field where its results would be productive of good, it is here, by restricting the supply and so enhancing the prices of men.

Involuntary pauperism and its attending evils will cease whenever the demand for men runs ahead of the supply.

I am not preaching Malthusianism as it is generally understood. It is *local over-population* and its accompanying unmanageability of which I speak. I have no doubt that this earth, if properly tilled and worked, will supply humanity with bread enough and to spare. But that will take many generations to accomplish. I am simply looking at things as they are, no matter how they came to be so. I can see that so long as human beings are brought into society at the present rate, and in the condition we are in, economics is not going to save them. One of the most hopeful signs in the spread of education is, that each class as it rises to a higher scale of knowledge lowers the percentage of its birth-rate. Where would your capitalists be with an extremely limited supply of labor? Given an exclusive community of millionaires, and what avail will be their millions? Riches and poverty are simply relative conditions. Your millionaire is rich only because there happens to be a herd of men extremely desirous of getting what he possesses. And a man believes himself poor if he does not possess those desirable things, even though he have enough to eat and drink and wear. One generation

would suffice to settle this anti-poverty question could you but hammer this fact into men's minds. I have often wondered how men reconciled the idea of a divine and all-wise Providence with that startling phenomenon—viz., the prolificness of the ignorant and the sterility of the wise.

There are two pleas which reformers urge in justification of their claims: the one, what they call "natural" justice, founded upon the imaginary "natural rights" theory; the other, expediency.

Prof. Huxley, in one of his series of vigorous articles published in the Nineteenth Century Magazine recently, and to which I refer you, has exposed at length the utter baselessness of the theory of "natural rights." It was this doctrine that had most significance, and became most famous prior to and during the great French Revolution through the writings and teachings of Rousseau and other French economists. It had been evidently borrowed from the English philosophers by Rousseau, and from the Romans by them. It forms the basis in Progress and Poverty for the justification of Mr. George's remedy for poverty.

So far as rights go, the rights we prize so dearly are, in fact, artificial rights, *not natural*—man-made, granted and secured by society. The natural condition is slavery. The civilized, the artificial, is freedom; and the curses that still hang over society, checking progress, are the presence of "natural" feelings and instincts with which man is still endowed. The limit of freedom will be approached the further man gets away from his "natural state."

The question of expediency is a difficult one to determine. All social changes, arbitrarily arranged, work misfortune to some, and these would question the "expediency" of the change with perfect propriety. The "greatest good of the greatest number" is an extremely rough method to determine "expediency," for there would be coercion of the smaller number.

On what grounds, then, are social problems to be answered? "Natural rights" being mythical, "expediency" being often indeterminable, is there no ground upon which to decide what is best? I think so. The attractive force that has drawn so many of us to study these social questions—that, in fact, led the authors of the various schemes enumerated to devise them—is human affection. I believe that the ground, and the only one, upon which permanent results and the best can be built will be an ethical one.

The remedies prescribed for poverty, by both anarchists and socialists, are based upon the assumption that under certain conditions all men will act alike, a fallacy that scarcely needs exposing. Under socialism it is supposed that the state administration

will be honestly carried out, that each and every man will do his duty, that there will be no "combines" on the part of overseers and administrators to turn the means of production to their own use and defraud the masses. For it is very certain that state socialism administered or superintended by such a class of men as that which recently met at Minneapolis to nominate *their* man, or the class that usually control the machinery of government in this "free" country, would not only fail in its purpose, but result in civil war, or the conditions of life would be worse than humanity has ever experienced.

Similarly, philosophical anarchism and the doctrine of non-invasion must fall short of its purpose unless all men confine themselves to their own business, and do not interfere with their neighbors. But the presence of a handful of men in an anarchistic community, who determined to live by plunder, would suffice to destroy either anarchism or the community.

Anarchy reminds one of a certain Chinese puzzle, the solution of which depended upon getting a number of different-shaped blocks together and dropping them at the same instant, so that they fell exactly into their respective places. If one happened to fall slightly out of place, it upset the entire number. Philosophical anarchy can only exist when all men have attained that condition where each fits his place and is content to remain in it.

I contend that no science of economics will elevate society to the condition its advocates believe, unaccompanied by a system of ethics. It is more a question of every man doing right, fulfilling obligations, guiding his conduct by some standard, than it is of the nationalization of land or the abolition of privilege. When every one is governed by his noblest impulses, in place of selfish instincts, poverty and misery will begin to disappear. Then the so-called science of economics will be rewritten, and a new basis of human action accepted. And, without this, no reform system will accomplish the purpose of its author.

"WHETHER it is possible," said Prof. Max Müller, at the International Oriental Congress, "to account for the origin of languages, or rather of human speech in general, is a question which scholars eschew, because it is one to be handled by philosophers rather than by students of language. I must confess, the deeper we delve the further the solution of the problem seems to recede from our grasp; and we may here, too, learn the old lesson that our mind was not made to grasp beginnings. We know the beginnings of nothing in this world, and the problem of the origin of language, which is but another name for the origin of thought, evades our comprehension quite as much as that of the origin of our planet and of the life upon it, or the origin of space and time, whether without or within us. History can dig very deep, but, like the shafts of our mines, it is always arrested before it has reached the very lowest stratum."

THE EVOLUTION OF THE ALPHABET.

By M. G. VALBERT.

STUDENTS of considerable merit have published solid and important studies on the writings of the Oriental world and the alphabet. Their work is now supplemented by the *Histoire de l'écriture dans l'antiquité*, of M. Philippe Berger (Paris, 1891), in which the attempt is made to give a comprehensive view of the whole subject. M. Berger has long been a careful student of Semitic languages and religions, and is engaged in the editorial work of the *Corpus Inscriptionum Semiticarum*. He is habitually careful in investigation, attentive to the facts alone, and is scrupulous to distinguish between what is proved and what is only half proved or has only begun to be proved. While he gives the highest credit for the introduction of the alphabet to the Phœnicians, he goes beyond them to the origin of writing in the primitive and crude processes to which thinking or almost thinking beings resorted in order to represent their mental conceptions by material and visible signs. He speaks of the notched sticks used by the Scythians and the Germans for correspondence and divining; of the wampum of the Iroquois—belts or necklaces of shells, the combinations of which formed geometrical figures, and which sometimes included as many as seven thousand pieces; of the *quippos* of the Peruvians—collections of woolen cords of different colors, in which knots were tied at different distances. Each color, and every peculiarity in the form of the knots, had its meaning. The Peruvians had employed another method before inventing the *quippos*. "It is curious," wrote the Spanish Jesuit Acosta, in the sixteenth century, "to see decrepit old men learning the *Pater Noster* with one round of pebbles, the *Ave Maria* with another, and the *Credo* with a third, and to know that that stone means 'conceived of the Holy Ghost,' and that other 'suffered under Pontius Pilate'; and then, when they make a mistake, taking them up again, looking only at the pebbles." The Iroquois made as good use of their wampum. The shells stood to them for ideas and phrases. Their messengers could convey with the aid of wampum entire speeches, which they would recite word for word on reaching their destination. But these, as M. Berger remarks, are not writing, but mnemonic expedients, methods by which an artificial memory was created. We do not write when we tie a knot in our handkerchief to keep from forgetting anything.

A closer approach to writing is pictography, or the art of exhibiting to the eyes what the mind sees or believes it sees. Man of the Quaternary epoch already practiced this art. We possess

bones and reindeer horns decorated with designs and sculptures, which sometimes represented veritable scenes. These designs, besides being mnemonic aids, are capable of transmitting thought as well as of preserving it. The day that these pictures were changed into recitals, man was ready to write. A scene engraved on a rock at Skebbevall, in Sweden, helps us to witness a landing of adventurers and their establishment in the country. Beside scenes of pursuit and piracy, are files of boats which we can count, with the braves aboard of them. Disks and groups of points above the scene indicate the time of the year or of the moon when it took place. Here the design is only in outline. Most of the boats are represented by two concentric curved lines, diversified with slight parallel strokes representing the braves. From this time the figure, abridged and truncated, is transformed into a sign, and that is a mark of writing. Man after this manifested that power of abstraction which is his privilege, and which consists in holding to that which is essential in things, and suppressing the rest. Man is, perhaps, the cousin of the monkey; but a chimpanzee will never be anything but a novice in abstraction, and that is why he will never take it into his head to speak or write.

Writing, as M. Berger says, is the art of fixing speech by conventional signs, traced with the hand, which are called characters. These characters may represent ideas or spoken sounds. That writing which aims to represent ideas directly is called ideographic, and the characters it employs are figurative. Some hieroglyphics are shortened images in which we can recognize, without too much effort, the sun, the moon, a mountain, a snake, a flower, a shoe, or a mirror. Then we deal with abstract ideas, we have recourse to symbols. A man kneeling, with his hands raised, conveys the idea of adoration; a hanging lamp, that of night; an open eye signifies vigilance and knowledge; an ostrich feather gives the idea of justice, because the wing feathers of that bird are all equal. The characters of phonetic writing, on the contrary, represent, not objects but the sounds composing the words that stand for those objects; and the writing is called syllabic or alphabetical accordingly as the characters express complex articulations or simple sounds, syllables or letters.

This distinction between the two methods is only theoretically correct. In reality nearly all systems of writing have, by a curious fatality, sooner or later come to syllabism. This occurred in the five great ideographic systems of the ancient world—the Chinese, the cuneiform writing of Assyria, Media, and Persia, and the Egyptian hieroglyphics. Egypt did not stop there, but pushed the analysis of the elements of speech still further, and, having disengaged the syllable, then disengaged the letter; and from the sixth

dynasty, or three or four thousand years before the Christian era, the inhabitants of the valley of the Nile had twenty-two different articulations, and used one or more alphabetical signs for each of them.

The Egyptians did not employ these alphabetical characters to the exclusion of all others. They also preserved some ideograms and a considerable number of syllabic signs, of which M. Maspero gives the list in his Histoire Ancienne. Thus, their writing was one of the most learned and most perfect, but also the most complicated, that could be imagined. The Phœnicians charged themselves with the duty of simplifying it, and they kept of the immense quantity of signs only those which corresponded with simple articulations, or consonants, and obtained twenty-two characters, which were sufficient to represent all the sounds of a language and all their possible combinations. Some Orientalists have looked for the origin of this alphabet in the cuneiform or Cypriote writing. M. Berger, discussing their theories, holds in the end, with Champollion, M. de Rouge, and M. Maspero, that the twenty-two signs were borrowed from the Egyptian writing, as it also came by natural development from the ancient pictographic writing. Greece adopted these characters, but not without adapting them to its limpid and sonorous language, which could not be satisfied with a writing exclusively composed of consonants; and, after having retouched them, it added a few signs expressive of the vowels. It gratefully acknowledged its indebtedness to the Phœnicians. It boasted of many things, but never boasted of having invented the alphabet. It called the primitive letters whence its classic writing was evolved, Phœnician or Cadmean characters, and showed its appreciation of Cadmus by making him a son-in-law of Jupiter. The Phœnician alphabet spread gradually through Asia as well as Europe, supplanting everywhere the cuneiform and hieroglyphic characters. Only China was the exception to this rule, and shut its doors against the alphabet. It has been discovered that even India, so proud of its chimerical antiquity, was indebted to the Phœnicians; and that the Sanskrit alphabet was not indigenous, but is derived, if not directly from the Phœnician, from one of its derivative alphabets, the Aramaic alphabet. "Nothing," says M. Berger, "is so imposing as this march of the alphabet to the conquest of the world. There is in it something of the irresistible and fatal character of the great invasions. In the face of the migrations of peoples which periodically precipitated the East upon the West, the Phœnician alphabet went against the current. Having established itself in the Mediterranean basin, it penetrated to the center of Asia from three sides at once; while its derivative, the Indian alphabet, occupied gradually the whole country south of

the Himalayas and diverged into Thibet, and the Syriac alphabet advanced directly across the central plateau. In the North, again, the Græco-Italian alphabet, after having gone the round of Europe, in advance of modern travelers, penetrated into the plains of Siberia. All the alphabets in use on the earth are derived from the twenty-two letters of the Phœnician alphabet. It would be hard to find in the history of discovery another example of an invention that has had so extraordinary a fortune." This prodigious success is easily explained. The Phœnicians found at the first stroke the formula for universal writing. They understood that the real purpose of the art of writing was to express the sounds of speech by visible signs; and those sounds being nearly the same everywhere, the same letters, slightly modified, have served for writing all languages.

The love of the human species for the complicated is strikingly illustrated in the story told by M. Berger. The simple comes after it, and has to wait its time with enduring patience. The history also shows how easily men may dispense with real goods while setting a high store upon imaginary ones. The world had already grown old, and had written for a long time, when the alphabet was invented, about 1500 B. C. Why did it hold during so many centuries to complicated and laborious systems of writing? Because they were better adapted to its wants. Writing served in ancient times for three purposes—for engraving inscriptions on stone, for correspondence with the absent, and for fixing the winged words of the poet. Inscriptions are of much less evident utility than correspondence and books; yet, epigraphic writing was the only use of which men then felt the need. The more monumental and decorative it was, the more it pleased them; and it must be acknowledged that the hieroglyphics of the Egyptians make a better showing on a wall than the twenty-two letters of the Phœnician alphabet.

The art of expressing ideas by simple traits was long an occult science, the exclusive property of a caste, of a sacerdotal caste, of a corporation of learned men and clerks. It did not matter that inscriptions were not understood by the multitude: those who had the key to them were charged with their explanation, and could give such interpretations of them as suited their interests. There are, in northern Africa, a large number of inscriptions, of various dates, some of them being several centuries old, and others quite recent. This writing, which is still partly in use among the Tuaregs, is intelligible only to the initiated, particularly to certain women, who keep it as a family secret.

A savage, who was shown his name written in characters that could be read, exclaimed in astonishment: "Where are my legs? where is my head? I see nothing there that distinguishes me."

The profane crowd to whom the initiated explained the meaning of an inscription may have been equally astonished, and would attribute a miraculous virtue to the written word. In the Edda Brynnhild teaches Sigurd the supernatural power of the runes: "Write the runes of victory if you would have victory; write them on the hilt of your sword; write others on the blade, speaking Tyr's name twice; write the runes of the storm if you wish to save your ship amid the roaring of the breakers; write the runes of thought if you wish to become wiser than others. Odin himself invented these runes."

It was not in northern countries only that men persuaded themselves that the word signifying power was powerful by nature, and the one giving the idea of God was divine. It was held as an article of faith in all countries that a written prayer had a sovereign efficacy, and that a curse engraved on stone had infallible effects. There are few epigraphic texts among those cited by M. Berger that do not end with a curse. It has been remarked that nothing is rarer than a proclamation of police that authorizes anything; not less rare is an ancient inscription intended to bless any one.

If the human race had never employed writing except to engrave inscriptions on stone, it would never have needed the alphabet. The prime merit of writing on stone was to be architectural, and unite mystery with majesty. But when commerce sought to utilize the art to facilitate business transactions it was necessary to simplify it, and place the occult science within reach of the multitude. The object was no longer to perpetuate sentences and memorable events, but to write in the easiest way the day's thoughts, for which posterity would not care. Paper and the calamus were substituted for stone and the chisel-point, and the cursive writing appeared, which is favorable, as M. Berger remarks, to idleness of the hand, inasmuch as it permits it to make with a single running line what had been made with many distinct lines, and is conformable to the law of the least effort.

Of the systems of writing derived from the Phœnician alphabet the most cursive found most favor, and made the most rapid progress abroad. The Aramaic system held this place in the Oriental world, and was accepted by all the Semitic peoples. The Egyptians, though not a commercial people, felt the need of an easier way of writing than by hieroglyphics for the common affairs of life, and formed a current hand from the hieroglyphics, which is called the hieratic. This was further simplified between the twenty-first and twenty-fifth dynasties, and the popular or demotic hand was invented for contracts and documents, for common use. But the Egyptians did not abandon their syllabic signs and ideograms, their homophones and polyphones, and the sim-

plest of their writings was still complicated. They had scruples against giving it up, and were inculpable of sacrificing their traditions and the love of the mysterious to the conveniences of life.

After it had become the universal tool of commerce, writing put itself at the service of writers and poets. Yet literature did without the alphabet for several centuries. The oral method sufficed for it, and verses and stories, in whatever dialect they were composed, passed from mouth to mouth. But the discovery, once launched upon the world, made a revolution in it. Suppress the alphabet, and all would be changed in the history of the human race. Three great religions, which have had a decisive influence on its destiny, would have been smothered in their cradles if the cursive writing had not served as a vehicle to carry them to distant points, and secure entrance for them. The Hebrews were acquainted with letters, and had a current writing. They were destined to be the people of one book. The law of the gospel must be a written law. Mohammed was to write, the world was to be governed by books, and these books were to make the fortune of the alphabet used in writing them. The Latin Bible, as much as the genius of Rome, carried the Latin alphabet into all western Europe. The Greek liturgy imposed the Byzantine alphabet on the Slavic peoples; and if all Africa ever learns to write and read, it will be indebted to the Koran for its knowledge of those arts.—*Translated for The Popular Science Monthly from the Revue des Deux Mondes.*

TO TIE A ROPE OF SAND.

By AGNES L. CARTER.

MORE than twenty years ago I was one of a great company of children who labored with wooden spade and pail on the beach at Long Branch. Never a corps of sappers and miners worked more industriously or more vainly. A mighty force, unhindered, or rather strengthened, by night and storm and winter, worked behind us, not merely leveling at a touch our tiny forts and mounds and trenches, but laughing at the utmost power and skill of wiser heads and stronger hands. Like Old Age, in the Norse fable, so persistent, so resistless, advances that mighty engineer, whose molding shaped our continent.

Is continent-making at an end? Did you think, O builder of hotel and cottage and esplanade, that Old Ocean had surrendered, and was under bonds not to invade the strip of white sand which borders man's territory?

When I plied my tiny spade in the Long Branch sands, a broad beach stretched below the bluff, while, above, a generous strip,

mantled with beach grass, extended to the wide drive. To-day the drive is only broad enough for the easy passage of two vehicles, on the very verge of a ragged bluff. Along the top of this bluff runs a railing, originally intended to define a footpath now ruined by the breaking of the bluff. It is not now possible for any but an athlete to walk outside the rail from one end of the beach to the other.

This is merely one sample of the New Jersey beaches. All are "cut up" by every storm. Year by year the danger to property from extensive floods is increasingly apprehended. In September, 1889, the sea overran almost the entire coast of New Jersey, causing great destruction of property and some peril to life. A few landholders have at last reached the point of thinking that "something ought to be done."

In several European countries the danger from incursions of the sea has long been the theme of history and song; and with this is joined the menace from the sand dunes which, forming in many places the vanguard of ocean's forces, may by man's industry be converted into the guardians and ramparts of the coast.

In Germany, Denmark, Holland, France, and parts of Great Britain those stories of drowned cities, of convents and churches whose bells the waves are said to toll in time of storm, are not the fairy tales they seem to us, but solid history, or at worst credible tradition, the framework of poetry and unending romance. Heine sings:

"In bright moon-glances rests the sea,
The waves' soft murmur falling;
So heavy is my heart in me,
The ancient bard recalling—

"The ancient bard who sadly tells
Of cities lost in ocean,
Where sound of prayers and peal of bells
Rise through the waves' commotion.

"The ringing and the prayers, I wis,
Avail the cities never;
For that which once deep-buried is,
Returns no more forever."

Lovers of Hans Christian Andersen will recall a pathetic tale of Jutland, ending in an ancient church submerged by whirling sand from the dunes on the shore of the Baltic. This was no poetic invention. "Near the beginning of the last century the dunes, which had protected the western coast of the island of Sylt, began to roll to the east, and the sea followed closely as they retired. In 1757 the church of Rantum, a village upon that island, was . . . taken down in consequence of the advance of the sand-hills; in 1791 these hills had passed beyond its site, the waves

had swallowed up its foundations, and the sea gained so rapidly that, fifty years later, the spot where they lay was seven hundred feet from the shore."

"The most prominent geological landmark on the coast of Holland is the Huis te Britten, *Arx Britannica*, a fortress built by the Romans, in the time of Caligula, on the mainland, near the mouth of the Rhine. At the close of the seventeenth century the sea had advanced sixteen hundred paces beyond it."—MARSH, *The Earth as Modified by Man's Action.*

"At Agger, near the end of the Liimfjord, in Jutland, the coast was washed away, between the years 1815 and 1839, at the rate of more than eighteen feet a year. . . . The sea is encroaching generally upon the whole line of the coast."—*Ibid.*

Facts like these have driven the Governments of Denmark, Prussia, Holland, and France to a careful consideration and study of the subject; and in all these countries a system of coast improvement has been adopted. This system does not imply a conflict with Nature, but rather a return to her earlier plan.

The sand-hills on the Prussian coast, up to the middle of the last century, were wooded to the water's edge. Old geographers, writing of the Netherlands, mention vast forests reaching to the sea. Of the fate of a Prussian forest we have the following record:

"A great pine forest bound with its roots the dune sand and the heath uninterruptedly from Dantzic to Pillau. King Frederick William I was once in want of money. A certain Herr von Korff promised to procure it for him if he could be allowed to remove something quite useless. He thinned out the forests of Prussia, which then, indeed, possessed little pecuniary value; but he felled the entire woods of the Frische Nehrung, so far as they lay within the Prussian territory. The financial operation was a success. The king had money; but, in the material effects which resulted from it, the state received irreparable injury. The sea winds rush over the bared hills; the Frische Haff is half choked with sand; the channel between Elbing, the sea, and Königsberg is endangered, and the fisheries in the Haff injured. The operation of Herr von Korff brought the King 200,000 thalers. The state would now willingly expend millions to restore the forests."—*Das Buch der Pflanzenwelt.*

It is estimated that about one million acres on the Atlantic and Baltic shores of Europe have become, since the destruction of the forests, a moving desert of sand dunes, rolling inland, burying the fertile soil, and rendering the land barren by the sand showers sprinkled over it; while, following the landward roll of the dunes, came the resistless march of the victorious sea.

The endeavor, then, of these threatened countries has been to regain, by slow degrees, the protection of the forests so rashly

destroyed. First, a breakwater or dike is constructed—occasionally a mere plank fence—against which the sand from the beach soon forms long rows of dunes. These sand-hills, usually the enemies of the land, being thus hindered from drifting inland, are impressed into the service of the land, and become its coast-guard against the invading waves. The second step is to plant them with beach grass, or some other sand-loving plant, to bind the sand together, and, by the succession of growth and decay, finally to form a soil.

We are accustomed to regard sand as utterly barren, but the plants native to the coast sands of Prussia have been enumerated by naturalists, whose estimates vary from 171 to 234 varieties. Of these one of the most available is the *Arundo arenaria* (marram), which thrives only in sand and in the salt air of the beach. This in time serves to prepare the soil for larger plants.

In France 100,000 acres of dunes have been reclaimed by planting. In that country the maritime pine (*Pinus maritima*) has been planted with great success. It does not, however, thrive close to the sea. The ailantus, a tree common enough in our land, and certainly sufficiently tenacious of life in our streets and fields, is a sand-loving tree. I have seen an abandoned cellar choked with healthy ailantus trees, and have known them to spring up from the root after being cut down and rubbed with salt! It is probable, then, that if it will grow on the beach it will hold its own against the ocean or any other enemy.

Finally, forests, and even vineyards and pastures, cover the space once resigned to the barren sand. "Every seed that sprouts binds together a certain amount of sand by its roots, shades a little ground with its leaves, and furnishes food and shelter for still younger or smaller growths. A succession of a very few favorable seasons suffices to bind the whole surface together with a vegetable network, and the power of resistance possessed by the dunes themselves, and the protection they afford to the fields behind them, are just in proportion to the abundance and density of the plants they support."—MARSH.

To return to our own country: It is said that the dunes of Michigan thirty years ago were clothed with trees, where now the sands are constantly shifting, and the lake beach changing with the action of wave and wind, while the lake level grows lower year by year. The sands of Cape Cod were formerly covered with beach grass, whortleberry bushes, and a peculiar species of dwarf oak. Dr. Dwight, in his Travels, speaking of a beach in Massachusetts, says:

"Within the memory of my informant the sea broke over the beach which connects Truro with Provincetown, and swept the body of it away for some distance. The beach grass was immedi-

ately planted on the spot, in consequence of which the beach was again raised to a sufficient height, and in various places into hills."

At Sea Girt, N. J., there is a strip of beach covered with cedar bushes. These have raised a natural dike. The sand, blown up the beach, is caught by the bushes and arrested, forming a long irregular bank of considerable height. The hollows behind this bank, protected from the surf, from the sea-breeze, and from destructive sand showers, could readily be reclaimed, fertilized, and made productive. For some years clover has been planted just above another part of the beach, and has produced a heavy crop. Those who, not many years ago, first beheld with wonder beautiful rose bushes and honeysuckle vines springing from the sands at Ocean Grove, will think little of the difficulty of covering these sands with vegetation sufficiently strong to withstand the inroads of the encroaching sea.

Thus, as the slight chain forged by the swart elves securely bound the savage wolf Fenrir, so may his brother, Jörmungund, the great ocean monster, be bound by a rope of sand.

NICKEL AND ITS USES.

By J. T. DONALD, M. A.

CONSIDERABLE interest attaches to the metal nickel at the present time, principally for two reason: In the first place, experiments recently made in France, England, and America have shown that steel alloyed with a small percentage of nickel forms an alloy possessed of great strength and remarkable resisting powers. In the second place, the past few years have witnessed the discovery and initial development on a large scale of what are said to be practically inexhaustible deposits of nickel ore in what is known as the Sudbury District, of Canada.

Nickel may be said to be a modern metal, for its history goes back no further than a century and a half, although the word is much older. The origin of the name is curious and interesting. The men working in the German copper mines often came upon an ore which, though looking like copper ore, did not yield copper when smelted. Such ore they called kupfer-nickel—i. e., goblin copper—because they thought the nickels or spirits of the mine were deluding them with bad ore.

In 1751 the Swedish mineralogist Cronstedt discovered a new metal, which, some three years later, he succeeded in isolating in an impure state. Finding that his new metal was most abundant in kupfer-nickel, he allowed it to retain the name suggested by the old superstition of the German miners.

It was many years after this, however, before the metal was obtained in a state of purity and its properties satisfactorily determined, and it was much later still when nickel, in a state of comparative purity, became an article of commerce; indeed, until recently it was hardly known in the pure state outside of the laboratory. In 1804 Richter experimented with this metal and obtained it fairly pure by reducing the oxide with carbon in an earthen crucible. Almost seventy years later, Wharton, of the Camden Nickel Works, Camden, N. J., who has devoted so much attention to the metallurgy of nickel, exhibited at the Vienna Exposition vessels of pure forged nickel, which he made by strongly compressing the spongy mass obtained by reduction of the oxide. These exhibits at Vienna, and similar ones at Philadelphia in 1876, and at Paris in 1878, received but scant attention from scientific visitors. Chemists and metallurgists, as a rule, supposed they were nickel alloy, and were somewhat incredulous when informed that the objects were pure nickel; in fact, the commercial production of pure nickel by Wharton, as evidenced by these exhibits, was a genuine surprise to the metallurgical world.

A further advance in the metallurgy of nickel was made by Fleitmann, of Iserlohn, Westphalia, in 1879. He found that the purest nickel he could obtain on a commercial scale had a brittleness which did not belong to the pure metal, and in the course of investigation he was led to believe that the brittleness was caused by occluded carbonic oxide. He decided to attempt the removal of this by adding magnesium in minute quantity to the molten nickel, and was successful beyond expectation, for the nickel thus treated quickly loses its brittleness.

As to the properties of nickel, it will suffice to say that it is a hard silver-white metal with a steel-gray tinge; it may be rolled into thin plate or drawn into wire; it is not readily oxidized; it is attracted by the magnet and readily assumes a polar condition.

Turning now to consider the uses of this metal, we find that Thénard in 1825, in his Traité de Chimie, stated that nickel was not employed for any practical purpose. This statement is true only in reference to the pure metal; for, just as brass was known and used long before zinc was isolated, so nickel alloys were known and used long before Cronstedt's discovery of the metal. The Chinese appear to have been among the earliest users of nickel alloys, for as early as 1776 it was pointed out that Chinese *packfong*—i. e., white copper—is an alloy of copper, zinc, and nickel. The beginning of the manufacture of these alloys in Europe is due to a somewhat curious circumstance. In the old slags from disused copper-smelting works at Suhl in Prussian Saxony, and once known as the armory of Germany, white granules of metal were found.

These were extracted and sold as Suhlian nickel silver, and in 1823 Brande showed that these white granules consist principally of an alloy of copper and nickel, and thus originated the manufacture of the widely used nickel alloys known as nickel or German silver. This German silver, so extensively used as the basis of electroplate, is, as is well known, an alloy of copper, zinc, and nickel, the proportions varying according to the use to which the alloy is to be put. Copper is the principal ingredient, and the nickel varies according to the color desired, for it is this metal that has the property of whitening the copper. Sometimes a little iron (from two to two and a half per cent) is added to the ingredients named, with the result of producing an alloy that is whiter and harder than the ordinary composition.

Doubtless all Americans know that nickel is used in coinage, but probably few are aware of the extent to which it is so used. As early as 1837 one Dr. Feuchtwanger, of New York, called attention to the suitability of nickel for coinage, and is said to have actually issued a number of one-cent and three-cent coins made of a nickel alloy. But the first national issue of a nickel-alloy coinage was made by Switzerland in 1850, the issue consisting of twenty, ten, and five centime pieces, containing respectively fifteen, ten, and five per cent of silver, alloyed with ten parts of nickel and twelve and a half parts of zinc, copper making up the balance. In 1857 an alloy consisting of eighty-eight parts of copper and twelve of nickel was adopted by the United States for the one-cent pieces. In 1860 Belgium instituted a nickel coinage, the alloy used for the purpose consisting of seventy-five parts of copper and twenty-five of nickel. This particular alloy appears to have given much satisfaction, for we find it adopted by the United States in 1865, by Brazil in 1872, by Germany in 1873, and still later by Jamaica.

It is not only in the form of an alloy that nickel is used in coinage. Improvements in the metallurgy of the metal have rendered possible a coinage of pure nickel, and it is interesting to note that Switzerland, which was the first to adopt a nickel-alloy coinage, was also the first to issue coins of the pure metal, the Swiss twenty-centime pieces coined in 1884 being pure nickel. In 1886 the Royal Berlin Mint executed for the Egyptian Government a nickel coinage, and during the same year a Birmingham firm coined in nickel five hundred thousand half-decimos and one million centimos for the Republic of Ecuador, while in 1887 Bolivia issued a nickel coinage. It thus appears that nickel is gaining in favor for subsidiary coinage, and not without cause. It is superior to copper in color, and, being more valuable, smaller coins are obtained; both the pure metal and the alloy are hard and thus wear well, and they possess the additional advantage

that they can be manipulated only by skillful workmen. In this connection it is worthy of note and illustrative of the old saying, "There is nothing new under the sun," that a coin of the Bactrian king Euthydemos,* who reigned about 235 years before Christ, is in composition very similar to the alloy adopted by Belgium, the United States, and other countries.

Nickel-plating annually calls for a large amount of the metal. The process is said to have been invented by Böttcher about 1848, and was first applied to firearms in order to prevent them from rusting, but is now applied to every description of iron and steel work. The effect, as is well known, is very fine, as the nickel, coating is white, bright, and hard, and, since it shows but very little tendency to oxidation, it retains its brightness for a long time.

Important as are the uses of the metal already indicated, the world's annual consumption has been small; not over a thousand tons was consumed in 1888, nickel-plating calling for more than half of this amount.

It is, however, in connection with one of the new uses of nickel —viz., as a constituent of nickel steel—that special interest attaches to the metal at present.

It is well known that nickel is frequently associated with iron in meteorites, and the view that the well-known and valuable qualities of meteoric iron might be due to the presence of nickel has not wanted advocates in the past.

Again, as far back as 1853, nickeliferous iron ores from Marquette, Mich., were found to produce iron possessing unusual toughness, a very white color, and a diminished liability to oxidation.

For a long time Nature's hints were neglected or disregarded, but in 1888 patents were taken out in England and France by different individuals for the preparation of nickel steel.

Tests of this alloy have been made by competent authorities, and the effect of the addition of small percentages of nickel to steel is seen in greatly reduced tendency to oxidation and increased strength. As an example of the superiority of this nickel steel, the following results of one of the tests may be given: A steel containing 4·7 per cent of nickel "showed an ultimate strength of thirty per cent and elastic limit of sixty to seventy per cent higher than those of mild steel, with a nearly equal ductility, and the valuable quality added of less liability to corosion."† The authority who obtained these remarkable results adds: "Think for a moment of this in connection with the erection of the Forth

* The Numismatic Chronicle, viii, 305; quoted by Roscoe and Schorlemmer.

† Journal of the Iron and Steel Institute, No. 1, 1889.

Bridge or of the Eiffel Tower. If the engineers of those stupendous structures had had at their disposal a metal of forty tons strength and twenty-eight tons elastic limit, instead of thirty tons strength and seventeen tons elastic limit in the one case and, say, twenty-two tons strength and fourteen to sixteen tons elastic limit in the other, how many difficulties would have been reduced in magnitude as the weight of materials was reduced! The Forth Bridge would have become even more light and airy, and the Tower more netlike and graceful, than they are at present." And Sir Frederick Abel, in his presidential address at the Leeds meeting of the British Association, remarked, "It has been shown by Riley that a particular variety of nickel steel presents to the engineer the means of nearly doubling boiler pressures without increasing weight or dimensions."

On the other hand, it must be admitted that there are those who maintain that the future of nickel steel has been painted in too rosy colors. For example, in Stahl und Eisen for October, 1889, Prof. A. Ledebeer criticises the claims made for nickel steel, and predicts that the alloys of nickel and steel "belong to that class of inventions which crop up at intervals, finally to be buried in oblivion because of their impracticability." The criticisms of this German writer were practically answered by a report in some of the trade journals immediately after the appearance of his criticism, to the effect that there existed among steel-makers a demand for several thousand tons of ferro-nickel for use in the preparation of nickel steel; and trials of armor plate made by a board of United States naval experts at Annapolis, Md., have shown that nickel steel is superior to ordinary steel for armor plate. As a result of these tests the House of Representatives at Washington made an appropriation of one million dollars for the purchase of nickel for use in the manufacture of armor for the new armored war-ships.

Coming now to consider the source of the nickel of commerce, we find it is derived principally from two classes of ores—viz., a nickeliferous pyrrhotite and a silicate of nickel. A very remarkable deposit of the latter occurs in New Caledonia, one of the New Hebrides and a penal colony of France, and since the period when productive work was begun on these deposits it may be said that the New Caledonia mines have entirely controlled the market. The ore known as garnierite is a hydrosilicate of nickel and magnesia, and is found in beds of serpentine mixed with oxide of iron, chrome iron ore, and a little cobalt. It is especially valuable on account of its entire freedom from arsenides and sulphides. Similar ores occur on this continent—for instance, in North Carolina and Oregon—but these deposits have not been developed to any extent. The discovery of the New Caledonia deposits aroused great

interest in industrial circles, as it was thought cheap nickel was thereby assured. Of late, however, the center of interest has moved from nickel silicate and New Caledonia to nickeliferous pyrrhotite and to the Sudbury District in the Canadian province of Ontario. The interest attaching to this district is due, not to the discovery of a new mineral or of nickel in a new association, if we except the occurrence of small quantities of platinum arsenide in the Sudbury ore; it is due to the richness of the ore and to the vast extent of the deposits.

Attention was first attracted to these by reason of the considerable masses of rich copper pyrite found close to the surface, and it was as a region of copper ore that Sudbury first became famous. At the depth of a few feet, however, the rich copper ores were found to be underlaid by pyrrhotite, which occurs in large lens-shaped deposits in an extensive belt of diorite. Scattered through the pyrrhotite is copper pyrite in threads, in mere specks, and in masses from the size of a pea to pockets containing several tons. The nickel contents of this pyrrhotite vary considerably. Scarcely any of it is entirely free from nickel, but the percentage varies from a trace to as much as eight or nine per cent.

An idea of the average value of the ore, and of the amount of nickel the district is capable of affording, may be gained from the particulars of the smelting operations of one of the companies that are working in this district to the end of December, 1889. One furnace ran 259 days and produced 3,849 tons of matte, said to average thirteen per cent of nickel and eighteen per cent of copper. A second furnace in 73 days produced 1,210 tons of matte of equal richness. In other words, 41,000 tons of ore produced matte containing 650 tons of nickel, and which was associated with 910 tons of copper, thus showing that the ore smelted averaged about one and a half per cent of nickel together with two and a quarter per cent of copper. All the nickel produced in this district finds a ready market, being used principally in the manufacture of guns and armor plate. It thus appears that the discoveries of the extensive Canadian deposits of nickel, and of the valuable qualities of nickel steel, are complementary one to the other.

PROF. MAX MÜLLER, in his address before the International Congress of Orientalists, expressed his objections to the word "prehistoric" as a vague term, that almost withdraws itself from definition. "If real history," he said, "begins only with the events of which we possess contemporaneous witnesses, then, no doubt, the whole period of which we are now speaking, and many later periods also, would have to be called prehistoric. But if history means, as it did originally, research, and knowledge of real events based on such research, then the events of which we are going to speak are as real and as truly historical as the battle of Waterloo."

SKETCH OF GEORGE FREDERICK WRIGHT.

PROF. WRIGHT has come forward within a few years to a foremost position among authorities in geology and the antiquity of man. His studies of glacial action have been thorough, extended, comprehensive, and fruitful of results beyond those of almost any other single observer, and make singularly fitting the curious designation given him by Judge Baldwin, Secretary of the Western Reserve Historical Society, as "the apostle of the Ice Age and Early Man."

GEORGE FREDERICK WRIGHT was born in Whitehall, N. Y., January 22, 1838. His parents were plain people, in moderate circumstances, not exempt from the necessity of labor, who, participating in the sentiment which that institution then represented, sent their son to Oberlin College, five hundred miles away. Thence he was graduated, from the classical course in 1859, and from the Theological Seminary in 1862. While in the Theological Seminary he responded to Lincoln's first call for troops, and enlisted as a private in the Seventh Ohio Volunteers. He served five months, and was then discharged after a severe sickness. During ten years from the fall of 1862 he served as pastor of the First Congregational Church in Bakersfield, Vt., in a parish from which, though it could pay its minister only the most modest of salaries, he was able to send many young men to the denominational colleges. Besides attending to his pastoral duties and engaging actively in revival work in his own church and in the surrounding towns, he entered vigorously into educational movements; started and presided over a vigorous farmers' club; studied the local geology and wrote articles for the country paper on the glacial phenomena of the region; read his Hebrew Bible through; and translated Kant's Critique of Pure Reason and several of Plato's philosophical works. His geological studies led to an acquaintance and correspondence with Prof. Hitchcock.

In 1871 he became pastor of a Congregational church in Andover, Mass., where he enjoyed the friendship of the professors in the Theological Seminary; made the acquaintance of Prof. Asa Gray, of Harvard; and began an active literary career. His eyes were open to the geological phenomena of the region—one of the first questions he asked upon his arrival, of a fellow-minister, relating to that subject. He was told that the country was under the glacial drift, and he soon gave his attention to that. "During his walks and drives he would stop to measure a 'kettle-hole,' or he would push far into the country to follow some gravel ridge. He made constant inquiries of fellow-ministers in other places as to the phenomena of their region. Every book that he could find

bearing upon glacial work he read, and as early as 1876 we find his observations extendedly reported in the Proceedings of the Boston Society of Natural History, under the titles of Some Remarkable Gravel Ridges in the Merrimac Valley, and the Kames and Moraines of New England. In this he showed that he had found a clew to a most important kind of glacial deposits which had heretofore been misunderstood." While he was engaged in preparing this paper Mr. Clarence King gave him information concerning the terminal moraine south of New England, which directed his attention to that quarter; and after that, he says, in the preface to his great work on the Ice Age in North America, the subject was never out of his mind, and all his summer months were devoted, under favorable conditions, to the collection of field-notes regarding it. Four seasons were given to making himself familiar with the glacial phenomena of New England; after which he was invited by Prof. Lesley to survey, in company with the late Prof. H. Carvill Lewis, the boundary of the glaciated area across Pennsylvania to the border of Ohio. The report of this work constitutes Volume Z in the publications of the Second Pennsylvania Geological Survey.

In 1881 Prof. Wright became Professor of New-Testament Exegesis in Oberlin Theological Seminary. Almost the first question he asked after his arrival in Oberlin was a geological one: "What is the age of the cañon of Plum Creek?" Plum Creek is a modest stream enough, but Prof. Wright made it and its work in denudation, in his Ice Age in North America, the basis of an important and interesting calculation concerning the antiquity of the Great Ice Age. In a similar manner he made use of the waterfalls of northern Ohio to illustrate the effect of glacial action on the appearance of the landscape. In the summers of 1882 and 1883 he was engaged, with the co-operation of the Western Reserve Historical Society, Cleveland, Ohio, in continuing the survey across Ohio, Kentucky, and Indiana; the results of which work were given in his report to the society, and in an article published in the American Journal of Science for July, 1883. The report proved to be the most distinguished publication ever made by the society. It was republished *verbatim* by the State of Pennsylvania, and has been published in substance by two other commonwealths. In it Prof. Wright described the spots where seekers might most profitably look for the evidences of man in glacial times, saying, "Man lived first below the glacial limit, and fished upon the banks of streams which were periodically gorged with the spring freshets of the Glacial period, and during those floods lost his spear-heads, his hammers, his axes, and his scrapers, where they became mingled with the gravel brought down from up stream." Palæolithic implements have

since been found at three of the places which he specifically pointed out.

During the summers of 1884 and 1885 he was employed with the United States Geological Survey in tracing the glacial boundary across Illinois, and in reviewing the field in Ohio and western Pennsylvania. His report of this work appeared in 1890, as Bulletin 58 of the United States Geological Survey, on The Glacial Boundary in Western Pennsylvania, Ohio, Kentucky, Indiana, and Illinois. In the summer of 1886 he visited Washington Territory and examined the Muir Glacier in Alaska, where he spent the month of August in company with the Rev. J. L. Patton and Mr. Prentiss Baldwin, collecting facts concerning the motion, size, present general condition, and probable past history and future career of the glacier. He devoted the two following seasons to the further exploration of Ohio and of Dakota, and other parts of the Northwest. "Thus," he says, "I have personally been over a large part of the field containing the wonderful array of facts" which he presents in his Ice Age in North America.

Since making these systematic explorations, while he has continued his outdoor work in various fields, Prof. Wright has devoted much attention to presenting the results of his researches to the public. He delivered courses of lectures on the subject before the Lowell Institute in Boston in the fall of 1887, before the Peabody Institute in Baltimore in 1888, and in Brooklyn, N. Y. The substance of these lectures, rewritten and much added to, was published in 1889 in his noble book, the Ice Age in North America and its Bearings on the Antiquity of Man, a large illustrated volume of 648 pages, which may be fitly described as one of the most valuable of recent contributions to the literature of geology, and as marking an important step in the advance of the science. The volume also contains an exhaustive discussion of the evidences concerning the early presence of man on the American continent, and particularly his existence during the ice age. Besides incorporating in this discussion the fruits of the discoveries of Dr. Metz in Ohio, of Cresson at Medora, Ind., and Claymont, Del., of Winchell and Miss Babbitt in Minnesota, of Dr. Abbott in the Delaware Valley, of Whitney in California, etc., he has introduced discoveries in regard to which he has himself made careful investigations; of the palæolithic implements found at Newcomerstown, Ohio, of the image found at Nampa, Idaho, under the basalt, and of a stone mortar found under Table Mountain in California. As a professor habituated to theological studies, the question of man's antiquity naturally followed him in these investigations, with the inevitable conclusion that the human period must be allowed an extension far beyond previous ideas of the subject, as well as the question of the method of reconciling the fact with

the chronology of the human race supposed to be given in the Bible. This subject is discussed in his Studies in Science and Religion (Andover, 1882) and Divine Authority of the Bible (Boston, 1884), and is dismissed in the book on the Ice Age with a reference to those works as containing all that it seems to be necessary for him to say on the point, and with the additional remark that "I see no reason why these views should seriously disturb the religious faith of any believer in the inspiration of the Bible. At all events, it is incumbent on us to welcome the truth, from whatever source it may come." The summer of 1890 was spent by Prof. Wright in the lava fields of Idaho and California, in careful investigations and verification of the evidences of man's antiquity recently found there, of which mention has just been made.

In the summer of 1891 Prof. Wright visited Europe, where his fame as a specialist in glacial geology had gone before him. Meeting the British geologists, he was warmly received by them, and was able to give them, through conclusions drawn from his American studies, information and light concerning the glaciation of their own islands and to bring about a satisfactory settlement of questions that had been in controversy among them. The results of his additional studies in Europe were given in an article in the American Journal of Science for January, 1892, and are more fully stated in his volume in the International Scientific Series, on Man and the Glacial Period, just published by D. Appleton & Co. In the winter of 1891–'92 Prof. Wright gave a second course of lectures in the Lowell Institute, to uniformly large audiences.

A movement has been set on foot among the alumni of Oberlin College living in Cleveland, Ohio, to endow a chair in that institution to be known as the Cleveland Professorship in Oberlin College of the Relation between Science and Revelation, which shall first be held by Prof. Wright. The call of the committee in charge of this enterprise mentions as a motive inspiring it the desire to enlarge and extend the work of the college in the direction of scientific investigation and instruction, and adds: "There are strong local and personal reasons relating to Prof. Wright's position and future work which urge immediate action in this matter. His ability and faithful services for many years in the department of New Testament Literature are appreciated. But there are other men, it may be, who can do this work as well as he; while, unquestionably, there is a field which he has made peculiarly his own, and which he is qualified, by tastes, studies, original researches, and authorship, still further to enrich and adorn. He has gathered facts from a wide range of investigation and proposed and proved theories which make him an authority

upon glacial geology, the antiquity of man, the relations of science and religion, and the proper interpretation and harmony of Nature and the Bible revelations. Having done so much for science in the vacations of his theological labors, it appears that the time has come when he should be enabled, by a transfer to such new professorship, not only to teach these special subjects, but also to pursue his studies and researches and to add to his publications respecting them. He has done the two things well, but can do the one thing better, and better than any other living man." The call goes on to give reasons why Prof. Wright and his work should not be severed from Oberlin College. The work has been carried on while in the service of that institution, and has been greatly assisted by the Cleveland (Western Reserve) Historical Society, "which has liberally promoted the studies in glacial geology which have shed new light upon the antiquities of Ohio, and enriched its collections of historical remains and the evidences of the prehistoric period. These local relations should not be disturbed." The committee specify as conditions of the endowment, which is fixed at $50,000, that the whole income be used by Prof. Wright, first for his salary at a rate fixed by the general rules of the college, and the remainder for the cost of travel, explorations, scientific books, and other aids and necessary expenses of his investigations, under the direction of the Board of Trustees of the college; that he be allowed one half of each year, free from class duties, for original work in his special field; and that his relations to the Cleveland Historical Society be continued. This plan has been approved by Prof. Wright and by the faculty and trustees of the college.

Besides his scientific publications, the more important of which have been mentioned, Prof. Wright is the author of many other works, chiefly on theological subjects. During his pastorate at Andover he published a number of articles in the Bibliotheca Sacra, notably one on the Theology of President Finney, and four on Darwinism. Numerous articles have appeared in the Nation, Advance, Congregationalist, and Independent newspapers, and others of considerable importance, in The New-Englander, The Atlantic Monthly, and Scribner's Magazine. His book, Logic of Christian Evidences, at once attained a large circulation, and is used in several schools and colleges as a textbook. He has presented the doctrines and evidences of Christianity in Studies in Science and Religion, The Relation of Death to Probation, and the Divine Authority of the Bible; and, since 1884, he has been editor of the Bibliotheca Sacra.

EDITOR'S TABLE.

THE FORMATION OF CHARACTER.

IN the preface to his Data of Ethics Mr. Spencer recognized the danger which might be apprehended from a weakening of the authority of existing moral systems before the authority of a more comprehensive and rational system should be established. The caution he thus gave fell, we have no doubt, with grave significance upon many ears. In not a few minds there must be a consciousness of more unsettlement than resettlement of moral ideas and standards; and, if so, it can hardly be that, in some cases at least, moral practice has not been unfavorably affected. Since the Data of Ethics was published, the ferment of thought in the world has been more rapid than ever; and it becomes a question of serious practical import by what means the minds and characters of the present generation, particularly of the younger portion of it, may be fortified against the perils attendant on their intellectual situation.

Let us take the case of a father whose son, brought up more or less in an atmosphere of advanced ideas, is showing a distrust of the traditional supports and sanctions of morality. The duty of the father is plainly to point out that the vitality or worth of a moral principle does not depend on the strength of the fortress which mankind in any age may have built for its defense. The principle is one thing, the wall surrounding it is another. The time must come, we believe, when all moral principles will be left simply to the care of man's enlightened reason, and when that protection will be sufficient. Meantime, as traditional defenses fall into decay, it is well to point out that walls so massive would not have been built unless the consciousness of men had told them that there was something precious to guard. Even the ceremonial observances of society, artificial and overstrained as they may sometimes appear, are the bulwarks of something that is essential to the well-being of men in their social relations. On this point Mr. Spencer, in the second volume of his Principles of Sociology, has well remarked that, "just as the abolition of religious restraints, while yet moral restraints have not grown strong enough, entails increase of misconduct; so, if the observances regulating social intercourse lose their sway faster than the feelings which prompt true politeness develop, there inevitably follows more or less rudeness in behavior and consequent liability to discord."

It is well, therefore, to say to the young, "Gain knowledge fast if you will, but remember that increase of knowledge does not always mean increase of wisdom, and may even result in its impairment if it nourishes an undue self-confidence." The poet Shelley was radical enough, yet even he confessed that the world had more knowledge than it could digest, or, in other words, rightly reduce to practice. If we compare the science of to-day with that of the opening centuries of our era, we find the difference almost immeasurable; but if we compare the wisdom of to-day, as shown in our best moral treatises or as exemplified in the lives of men, with the wisdom of that period as expressed in the works of such writers as Seneca, Epictetus, and Marcus Aurelius, and as embodied in their lives, the difference is far less marked. A man of our time who took his science from Lucretius would wander in gross darkness; but a man who took the treatise On Duties by Cicero, the contemporary of Lucretius, as his guide in moral questions would not be led far astray. This

simple consideration should moderate the ardor of those who think that, because the domain of scientific knowledge has been wonderfully enlarged, all things must have been made new in the moral order as well. That is not the case: the main outlines of morality will remain as they were traced centuries ago, the reason being that they were traced not on theoretical lines, but on lines directly suggested by experience. There are not wanting voices in the present day that whisper, nor even some that shout, that the age of restraint has passed away, and that nothing is now forbidden to the emancipated spirit of man. Such teaching is dangerous, and, just in so far as it is listened to, will the wisdom of the past rise up to reprove the folly of a lawless present, and experience set its seal on the reprobation.

The wise parent will follow a just mean between inculcating unquestioning deference to established beliefs and practices and stimulating a spirit of rebellion against whatever can not produce its logical credentials in a shape suited to the critical temper of the times. Room must be left for intellectual growth, and the mind must be allowed to go on voyages of discovery of its own; but as a preparation for such voyages a disposition, not to accept with absolute submission, but at least to respect—in some measure to reverence—the principles of morality which the experience of mankind has slowly elaborated, will be found to be of no mean value.

> "Me this unchartered freedom tires,
> I feel the weight of chance desires,"

says the poet Wordsworth in his Ode to Duty. The poet felt their weight; others, less happily constituted, have experienced their danger, for not every one can join in the affirmation:

> "Through no disturbance of my soul
> Or strong compunction in me wrought
> I supplicate for thy control,
> But in the quietness of thought."

Some parents who have no wish to launch their children on too adventurous a career nevertheless help to do so by unduly stimulating, or not wisely repressing, their egotism, and by emphasizing too strongly or without due discrimination the importance of individuality. Not every seedling is worth cultivation, and a given individuality may be little better than a "freak." The true advice to give to every one is, not to abound in his own peculiar sense for the sake of being different from others, but to choose wisely an object in life and to develop his nature to the utmost in the effort to advance that object. The proof of a pudding is in the eating, and the measure of the value of an individuality is not the angle of its divergence from the normal, but the amount of effective help it can give to the work of the world.

The character of every human being will be largely shaped by heredity: the function of education is to repress as far as possible all hurtful tendencies by bringing their nature and consequences into prominence, and to call into activity such useful faculties or traits as threaten to lie dormant. The wise educator will not, however, proceed on any Procrustean plan. His aim will not be conformity to an arbitrary or conventional model, but simply the production of the best possible results from the particular type submitted to him; and he will respect individuality in this sense, that he will know that Nature sometimes does more in one stroke than education can accomplish in a hundred years. It is hardly necessary to say, in conclusion, that the formation of character is by far the most important problem in education. Give us learning, give us accomplishments, give us talents if you can; but above all strive to give us men and women fitted for life and its activities, for its joys, its sorrows, and its struggles, fitted to be happy themselves and to make others happy.

TENNYSON.

MUCH as has been written about the great poet who was laid to rest in Westminster Abbey on the 12th of October last, a few words may properly be devoted to him in this place on account of the marked influence which his writings have had upon the intellectual movement of our time. In him there was an admirable balance and harmony of the logical and emotional powers. Through the former he was in sympathy with the most progressive thought of the age; through the latter, coupled with a noble imagination, he was enabled to enrich the English language with lyrics of priceless value and to infuse into the great body of his poetry the warmth and glow of a high moral inspiration. In many respects Tennyson was an ideal poet. While alive to the controversies of the time, he held a place apart, and never did or suffered aught of a nature to impair the great and ever-increasing consideration in which his name was held. He confined himself strictly to his own region of poetry, not seeking to shine as a prose writer, a critic, a theologian, or a man of society. At the same time his poetical throne was well within view of the people. His style was free from the all but hopeless obscurity of Browning, and yet it was marked by a certain distinction and refinement of thought which placed it just beyond the reach of the intellectually vulgar. Though a "gentleman" by birth, he had sincere popular sympathies; and though an upholder of church and state, his theology was of a very broad and liberal pattern. All things considered, he was in an admirable position for interpreting this age to itself; in other words, for making his contemporaries conscious of the spirit and tendencies of the time. His thought was fresh and forward-glancing in the early years of the century, and in the latest it was still in sympathy with all true progress.

No one can read any considerable portion of the poetry of Tennyson without perceiving his interest in scientific thought. He tells us himself, in Locksley Hall, in a touch which may be regarded as autobiographical:

"Here about the beach I wandered, nourishing a youth sublime
With the fairy tales of science and the long results of time."

In certain well-known stanzas of In Memoriam he has given us a vigorous sketch of the evolution theory, even anticipating the views of Darwin on the descent of man. That he studied the stars is evident from many allusions. Take the beautiful verses from Locksley Hall:

"Many a night from yonder ivied casement ere I went to rest,
Did I look on great Orion sloping slowly to the west;
Many a night I saw the Pleiads rising through the mellow shade,
Glitter like a swarm of fire-flies 'tangled in a silver braid."

In The Palace of Art he tells how—

. . . "while Saturn whirls, his steadfast shade
Sleeps on his luminous ring";

and in The Princess how

. . . "the fiery Sirius alters hue,
And bickers into red and emerald."

That he did not sympathize with the attacks of theologians on scientific speculations may perhaps be gathered from the following lines in the Prologue to his Morte d'Arthur:

"Half awake I heard
The parson taking wide and wider sweeps,
Now harping on the church commissioners,
Now hawing at Geology and schism;
Until I woke and found him settled down
Upon the general decay of faith
Right through the world—'at home was little left
And none abroad: there was no anchor, none,
To hold by.'"

That he placed but limited faith in ecclesiastical authority is more than hinted where he says to the Rev. F. D. Maurice:

"Should all the churchmen foam in spite
At you so careful of the right,
Yet one lay-heart will give you welcome
(Take it and come) to the isle of Wight."

In the preceding verse he had intimated that he would not mind in the least if "eighty thousand college councils" had "thundered anathema" at his friend. His references to the clergy, indeed, were not in general flattering; and this, considering that his own father whom he greatly revered was a beneficed clergyman, is a little remarkable. When the old woman in The Goose began to grow rich with her golden eggs, "the parson," we read, "smirked and nodded." In Maud we read of "the snowy-banded, delicate-handed, dilettante priest"; and in the Northern Farmer we do not get a deep impression of the value of the ministrations of the parson whom that worthy, when he went to church, heard "a bummin' away" over his head. At the same time the tone of Tennyson's mind was essentially reverent. Without cramping his thought he bowed his will to a Power that he recognized as divine. No man ever faced intellectual difficulties more fully and fairly than he did. He would sometimes solve his difficulties by what Comte has called "the logic of feeling" in a way which is not given to all of us, but he never laid false pretensions to argumentative victory. In his Two Voices he lets the evil spirit have its say to the fullest extent, and then answers:

"I can not make this matter plain,
But I would shoot, howe'er in vain,
A random arrow from the brain."

So in In Memoriam there is earnest aspiration and even affirmation, but no dogmatism, no appeal to authority or reliance on authority.

To the moral law Tennyson throughout his works is unfailingly loyal. If, as he says, he received his laurel "green from the brows of him who uttered nothing base," he has bequeathed that laurel as fresh and stainless as he received it. We can not think of a better course of moral hygiene than a selection which might be made from the late laureate's poetry. The Palace of Art tells most powerfully of the misery of selfishness; the Idylls of the King are a noble and impassioned plea for truth and fidelity; Maud and Locksley Hall strike all the chords of high and generous feeling; and The Princess sets the relations of the sexes in a light which is familiar enough to us to-day, but which forty-five years ago had almost the character of a gospel. It may be said of Tennyson's Muse that, while the world in which she lives and moves is a noble one, it is not an impossible one: hence the benefit of reading Tennyson; the virtues which he depicts and glorifies are essentially human in their character and make for the perfection of human life. They are within our reach if we will but strenuously grasp at them. If the verse of Tennyson had descended into the grave with him, the world to-day would be a grievous loser; but while we mourn the poet who gladdened and instructed our age, we rejoice to think how much he has left that our children and our children's children will prize not less highly than we, and that will extend its healthful influence through ages to come.

LITERARY NOTICES.

MAN AND THE GLACIAL PERIOD. By Prof. G. FREDERICK WRIGHT, author of The Ice Age in North America. With an Appendix on THE TERTIARY MAN, by Prof. HENRY W. HAYNES. With Three Folded Maps, and 108 Figures, Maps, and Sections in the Text. New York: D. Appleton & Co. (No. 69 of the International Scientific Series.) 12mo. Pp. xvi+385. Price, $1.75.

THE rapid progress of scientific investigations during this latter half of the nineteenth century has been scarcely less surprising than the countless applications of invention in manufactures, in the vast development of railroads, and in the uses of electricity for the telegraph and telephone, and for motive

power and light. Within the past hundred years the science of geology has sprung into existence, and only about fifty years ago its division known as glacial geology began with the grand work of Agassiz in his study of the glaciers in the Alps, of their former extension across the wide valley of western Switzerland to Mont Jura, and of the glacial drift in Great Britain which he at once saw to be due to the former presence of sheets of land ice. At nearly the same time, in 1841, Boucher de Perthes made the first collection of stone implements in the gravel terraces of the Somme Valley, by which geologists and archæologists were reluctantly convinced that the human race dates back to a remote prehistoric period, since which time very great changes of climate have taken place and the valleys of many rivers have been eroded far below their old flood plains. Because of the relationship of the earliest traces of man with the Glacial period, this latest part of the geologic record has attracted the interest of many observers and nearly all readers; new and important discoveries are being made every year, and a vast amount of literature in scientific journals and government reports is constantly accumulating; but many difficult problems in this field remain still under discussion, concerning measurements of the antiquity of man, the duration of post-glacial time and of the Ice age, the causes of its climatic changes, and whether it consisted of only one epoch of glaciation or of two or more separated by mild and warm interglacial epochs when the ice-sheets were melted away. Among these observers and writers none during recent years has traveled more extensively to gather information or been more successful in contributing to our knowledge than Prof. Wright, who in this book, as in his previous larger volume, treats this subject in a clear, vigorous, and entertaining style.

Agassiz reasoned, from the action of the Swiss glaciers in their wearing the rock surfaces over which they moved, and in their transportation of drift and formation of terminal moraines, that all countries bearing such marks or striæ on the bed-rocks and similar deposits of till, or intermingled bowlders, gravel, sand, and clay, have been overspread by ice. Prof. Wright similarly devotes fifty pages to descriptions of glaciers now existing, and of the ice-sheets of Greenland and the Antarctic continent, before considering the evidences of past glaciation. On the Sierra Nevada and Mount Shasta living glaciers are found, but are of very small size. Northward they occur in increasing numbers and abundance on the Cascade Range and in the Selkirk Mountains and the Coast Ranges of British Columbia and Alaska. About one hundred and fifty miles north of Sitka the Muir Glacier, which was explored and mapped by Prof. Wright in 1886, has an extent of about three hundred and fifty square miles; and the Malaspina Glacier or ice-sheet, lying between Mount St. Elias and the ocean, mapped by Russell in 1890 and 1891, covers some fifteen hundred square miles. These are very far surpassed, however, by the Greenland ice-sheet, explored by Rink, Nordenskiöld, Nansen, and Peary, which probably has an area of half a million square miles; and the Antarctic ice-sheet is ten times more extensive, occupying, indeed, a somewhat greater area than the northern half of North America, which was enveloped by ice during the Glacial period.

The terminal moraines of the ancient ice-sheet of this continent have been traced by Wright, Chamberlin, Salisbury, Leverett, Upham, and others, from Nantucket and Cape Cod, westward through Long Island, northern New Jersey and Pennsylvania, Ohio, and other States to Minnesota and North Dakota; and farther westward the glacial boundary crosses Montana, Idaho, and Washington to the Pacific south of Vancouver Island. Stone implements proving the presence of man here during the Ice age have been found in plains and terraces of modified drift deposited in valleys by streams flowing from the melting and receding ice-sheet in New Jersey, Ohio, Indiana, and Minnesota. Equal or greater antiquity must be also affirmed for the Calaveras skull, stone mortars, pestles, and spear-heads which have been obtained by Whitney, King, Becker, Wright, and others, from the gold-bearing gravels under the lava of Table Mountain in California.

In the chapter on the ancient glaciers of the Eastern hemisphere a very valuable contribution of more than forty pages is from the pen of Mr. Percy F. Kendall, relating to the glaciation of the British Isles, with a map

showing their contour and the areas covered by their ice-sheets. Mr. Kendall fully sustains the conclusions of the late Prof. Henry Carvill Lewis, that the British drift was due to land ice, with no considerable marine submergence of any part of these islands. The marine shells, mostly fragmentary, which are found up to the height of about fourteen hundred feet on Moel Tryfaen, are confidently ascribed to currents of the ice-sheet flowing southward over the bed of the Irish Sea, plowing up its marine deposits and shells and carrying them upward as glacial drift to this elevation.

Norway, Sweden, and Denmark, the North Sea and the Baltic, northern Germany, and a large part of Russia, were enveloped by an ice-sheet which flowed radially outward from the Scandinavian mountains and plateau. Bowlders of Scandinavian rocks were brought across the present area of the North Sea to Yorkshire in England. Moraines of this ice-sheet have been traced across Germany by Prof. R. D. Salisbury, who finds them closely like the moraines that he had previously explored in the northern United States.

Many relics of palæolithic man, contemporaneous with the Glacial period and with numerous extinct species of animals, have been found in river gravels and in caves in Wales, England, France, Belgium, and Germany, which Prof. Wright has well described. He does not proceed, however, to treat of the neolithic and later races of men, who have inhabited Europe since the Ice age. The glacial type of man is represented by portions of skeletons, including skulls, exhumed many years ago in Canstadt and Neanderthal, Germany, and recently by Profs. Lohest and Fraipont in the commune of Spy, Belgium.

The author believes that all the phenomena of the drift can be better explained by a single Glacial epoch than by two or several such epochs divided by long intervals of mild or warm climate. In this opinion he differs from most American glacialists, from Prof. James Geikie and others in Great Britain, Wahnschaffe in Germany, Penck in Austria, and De Geer in Sweden; but is in agreement with Lamplugh in England, Falsan in France, and Holst in Sweden, who attribute the fossiliferous beds inclosed between deposits of till to oscillations of the front of the ice, rather than to its complete departure and return. "So far as we can estimate," says Prof. Wright, "a temporary retreat of the front, lasting a few centuries, would be sufficient to account for the vegetable accumulations that are found buried beneath the glacial deposits in southern Ohio, Indiana, central Illinois, and Iowa, while a temporary readvance of the ice would be sufficient to bury the vegetable remains beneath a freshly accumulated mass of till." With reference to the argument for two distinct glacial epochs in North America drawn from the greater oxidation of the clays and the more extensive disintegration of certain classes of the bowlders found over the southern part of the glaciated area, attention is directed to the superficial decay of the rocks before the Ice age, like that now observed outside the drift region. "There was an enormous amount of partially oxidized and disintegrated material ready to be scraped off with the first advance of the ice, and this is the material which would naturally be transported farthest to the south; and thus, on the theory of a single Glacial period, we can readily account for the greater apparent age of the glacial *débris* near the margin. The *débris* was old when the Glacial period began."

As to the causes of the Ice age, the author points out strong objections against the astronomic theory which has been so ably advocated by Croll, Geikie, and Ball. Measurements of the rates of erosion of the gorges below the falls of Niagara and of St. Anthony, as shown by Gilbert and Winchell, allow us no more than seven thousand to ten thousand years since the end of the Glacial period, instead of the eighty thousand years required by Croll's theory. Geographic conditions seem more likely to have produced the glacial climate, continental ice-sheets, and formerly more extensive glaciers on mountain ranges. According to Dana, Upham, Le Conte, Jamieson, and others, submarine river channels and fjords, reaching down three thousand to four thousand feet beneath the sea-level, prove that these glaciated areas were greatly uplifted, probably attaining such altitudes that their precipitation of moisture was mostly snow throughout the year; and the snow and ice may have been more rapidly accumulated because of changes in the oceanic circulation by submergence of the Isthmus of Panama.

Prof. Wright concludes that the earliest men, so far as we know of their antiquity by that of the Ice age, lived perhaps thirty thousand to forty thousand years ago. He assumes that the elevation of the northern part of our continent and of northwestern Europe at the close of the Tertiary era may have been at the rate of three feet a century, like the present uplifting of some portions of Scandinavia, so that in one hundred thousand years they would be raised three thousand feet, which is thought probably enough to cause the accumulation of the ice-sheets; and for the reign of the ice or duration of the Glacial period he accepts Prestwich's estimate of about twenty-five thousand years.

The question whether man existed, as has been claimed, in Europe or in California during the later part or even the middle of the Tertiary era, far longer ago than the Ice age, is examined by Prof. Haynes in an appendix of this work, showing that no reliable evidence of Tertiary man has been yet discovered.

THE CASE AGAINST BIMETALLISM. By ROBERT GIFFEN. New York: Macmillan, 1892. Pp. 254. Price, $2.

IN the domain of the physical sciences the results of research, when acquiesced in by those competent to judge, take their place as a part of the body of accepted truth, and are no longer open to discussion. In sociology, however, the demonstration of any proposition, and the concurrence of all competent judges in its truth, carries no such weight with the mass of people. This is particularly true in economics. The demonstration that entire freedom of trade is essential to the fullest working out of the economic life of a nation is as old as the science, yet we have the spectacle of the greater number of the advanced nations of the world clinging to the opposite policy. Another of the fallacies to which great numbers adhere, in the face of repeated demonstration that it is a fallacy, is bimetallism. And in this case this most pernicious doctrine finds adherents, not alone among the masses of the people, but among otherwise instructed economists as well. It has been demonstrated over and over again that a dual standard of value is a delusion; in fact, has been so thoroughly demonstrated that adherence to the idea is not a whit more creditable intellectually than is the pursuit of a perpetual motion. Mr. Giffen may, therefore, be forgiven for having but little patience with bimetallism or its adherents. He very properly feels that an economist should not be called upon to continually discuss a question that is already settled; but the continual reappearance of this doctrine and its wide popular support renders it necessary to restate from time to time the economic facts and to examine the alleged practical results. The present book is not a systematic treatise, or even a series of essays grouped in a logical order, but consists of miscellaneous papers contributed to various periodicals, letters to The Times, and addresses. The general scope of this collection of papers is indicated by the titles, which are as follows: The General Case against Bimetallism, On some Bimetallic Fallacies, A Problem in Money, The Inevitable Results of Universal Bimetallism, M. de Laveleye on Mint Price, The Alleged Bimetallism of France, 1803–'73, Unsalable Silver, The American Silver Bubble, and A Chapter on Standard Money. In an appendix there is a further consideration of the case of France, and also a number of extracts from debates in the House of Commons on bimetallism in 1830.

The general tenor of Mr. Giffen's positions is that nothing that a government can do can alter the relations of the two metals, gold and silver, as determined by economic forces; and that if you could tie the metals together at some particular ratio and hold them there, nothing whatever would be gained. You can't, however, do this, so that in all cases of attempted bimetallism what you really have is a shifting standard, first gold, then silver, and so on back and forth, as the market value of the metals varies. The idea that governments, either singly or all together, can give a price to either of the metals different from the bullion price is fitly characterized by Mr. Giffen in the following extract from his paper on Mint Prices: "M. de Laveleye's idea, first of all, is that the impression of a metal with certain stamps by the mint is the fixing of a price for it. If you take an ounce of gold to the mint, he says, it is coined into

£3 17*s.* 10½*d.*, and that is the price of an ounce of gold. This is as much as to say that if you send a cask of beer to the bottler and he fills one hundred bottles with the contents, the one hundred bottles is the price of the cask of beer. Of course, the gold and the beer before and after coining and bottling respectively are the same, and the £3 17*s.* 10½*d.* is an ounce of gold and not the price of it, just as the contents of one hundred bottles are the beer that was in the cask and not the price of it. I need hardly add that this talk of a mint price is the old and time-worn talk of the currency faddists who believe in inconvertible paper."

It is a great pity that books like this of Mr. Giffen can not find their way into the hands and minds of those smitten with the silver mania, and who have been brought to regard the much-abused metal, as they term it, with emotions akin to those excited by contemplation of the forlorn and oppressed.

THE SPEECH OF MONKEYS. By R. L. GARNER. 8vo, pp. 217. New York: Charles L. Webster & Co. Price, $1.

IN the title of this book lies the potency which has prompted the acceptance of Mr. Garner's various essays on the subject by the leading reviews. The honest enthusiasm of the author and his positiveness have given a charm and virility to his writings, and made them attractive reading.

The initiatory impulse which has impelled Mr. Garner with unparalleled persistency arose in early childhood, from a superstition, common to all children and savages, that animals talk among themselves. This belief, instead of being outgrown by Mr. Garner, became the dominating impulse of his life—has animated him to the most painstaking efforts, and to the most sanguine utterances. The book abounds in surmises to be answered in only one way; no effort is made to even suggest any other conclusion than the one which supports his thesis. On the very first page, for instance, he wonders how it has occurred to man to whistle to a horse and dog instead of using some sound more like their own. He says, "I am at a loss to know how such a sound has ever become a fixed means of calling these animals." The simple answer should have occurred to Mr. Garner that a whistle is easier to utter, is heard farther, and is not only the universal call for dogs but for boys and men. The whistle of the boatswain, postman, policeman, and car-shifter shows the simple utility of this kind of a sound as a call or a signal note.

His experiments with monkeys are very interesting and amusing; his explanations, however, can often bear a different interpretation; thus, on page 76, he describes an experiment with a glove to which he had attached a string by which he drags the glove slowly toward him across the floor. The monkey, on first seeing it at a distance, gives a low note of warning, and as the glove approaches she makes a louder note. He says, in regard to these subdued notes of warning, "Her purpose was to warn me of the approaching danger without alarming the object against which the warning was intended to prepare me." It may be observed, however, that all emotional sounds made by animals increase in loudness just in proportion to the excitement occasioned by the cause.

Mr. Garner's interpretation of the gesture for negation seems quite reasonable. His experiments with the phonograph inspire him to further efforts "to find out the fountain-head from which flows out the great river of human speech." Mr. Garner should know that if he is to go to the fountain-head he is not to run out to the extreme tip of one of the twigs which branched off in the Tertiaries, but rather to study the half-apes and the lemurs if he is to get the remotest light on the subject.

A preparation for the work Mr. Garner is engaged in should have been prefaced by an exhaustive study of the emotional sounds emitted by man—sounds quite distinct from articulate utterances which form words and sentences. As an illustration of these sounds, let one witness a base-ball game and observe the different cries which go up from the audience at different points of the play. A few years ago there was a gate-keeper at the Brooklyn base-ball grounds who, though far out of sight of the game, could tell by the kinds of sounds emitted by the multitude precisely what was happening on the field. With unerring certainty he could say, "There's a hot ball caught from the bat," or "man put out at first," "home-run," "caught on the fly," "rank decision," etc. And yet these

sounds were all emotional and inarticulate. Now, when so many details of a complex game bring out a variety of symphenomenal expressions, why may we not insist that the so-called speech of monkeys as well as of other animals is of the same nature?

We do not doubt Mr. Garner's earnestness, but lament his impetuous tendency to see one side of the question only. His experiments with the phonograph and his studies of the subject should be encouraged, as the collection of facts will be of great value, even if his theory of speech falls to the ground. The book is interesting reading throughout.

LESSONS IN ELEMENTARY BIOLOGY. By T. JEFFERY PARKER, F. R. S., Professor of Biology in the University of Otago, Dunedin, New Zealand. London and New York: Macmillan & Co. Pp. 408. Illustrated. Price, $2.25.

THIS work differs essentially in purpose and treatment from the standard Practical Biology. Although the author admits the value of Prof. Huxley's "sound canon of instruction," to proceed from the known to the unknown, yet he clings to the earlier method pursued in teaching biology, analogous with the order of evolution, advancing from the simple to the complex, and defends it upon logical grounds. He recognizes the danger of overwhelming the hapless student at once with unfamiliar objects, new means of observation, and a strange tongue, and suggests a compromise. Disregarding the arrangement of the book, practical class-work may begin with a study of a flowering plant and of a vertebrate animal. The pupil will then be sufficiently acquainted with the terminology and microscopical work to take up the lessons in the order given.

The book, however, is designed for the study rather than the laboratory, and the life processes of different types are described and illustrated with such detail that actual handling of the objects is not essential to a fair acquaintance with their changes of structure. Beginning with amœbæ, representative forms are considered in the order of increasing complexity until examples of the higher plants and animals are reached. At intervals, special lessons are devoted to important topics: cell structure and nuclear division; biogenesis, homogenesis; the origin of species; distinctive characters of animals and plants; reproduction and embryology. The various modes of nutrition, digestion, movement, and generation are treated in connection with each individual organism.

The aim of the author, "to give a fairly connected account of the general principles of biology," is very carefully carried out, and those who desire to gain an insight into the science are materially assisted by a glossary. In this the author has given to several botanical terms a zoölogical meaning, striving toward a more consistent nomenclature; but the student will be grateful, without regard to these innovations, to be saved the thankless labor of searching for words that the average dictionary does not define.

TRANSFORMERS. By CARYL D. HASKINS. Bubier Publishing Company, Lynn, Mass., 1892. Pp. 150. Price, $1.25.

IT not infrequently happens that an apparatus, machine, or method of work which was discarded in the early stage of a developing industry, becomes later, by the progress of the industry, to be very important. This has been the case in the application of electricity to the production of light. It began with the alternating current, and is now returning to it. The use of this type of current is now becoming so general that it would not be beside the mark to say that future progress in the application of electricity will all be in this direction. An increasing amount of incandescent lighting is being done with it, and it needs only the development of a satisfactory alternating-current motor to render it available for all power purposes for which the continuous current is now employed. The marvelous flexibility of this form of current is what constitutes its great commercial advantage. You can start with a current of any tension and volume you please, and produce at the operating point a current of any other tension and volume that you desire within the limits of the original energy. You can step up to higher tension or down to lower tension, or do both in succession. All this is accomplished by the use of the transformer—a form of induction coil This, which is the vital part of the alternating-current system of distribution, forms the subject of this little volume of Mr. Haskins.

The book is primarily addressed to working electricians who have charge of alternating-current apparatus, but it may be read understandingly by any one who is sufficiently interested in the progress of electricity to have taken the trouble to acquire a rudimentary knowledge of the subject.

The book opens with a brief consideration of the phenomena of induction and its application to the transformer. A chapter is given to a mathematical consideration of it, one to the changes it has undergone to fit it for commercial use, and one each to its construction and its use in practice. The book closes with a description of the chief commercial transformers. Various miscellaneous subjects, which could not well find a place in the body of the book, are noticed in an appendix.

INDUCTION COILS. By G. E. BONNEY. New York: Macmillan & Co., 1892. Pp. 231. Price, $1.

THE author has essayed in this volume to give such practical knowledge of the methods of constructing and operating induction coils as will be of use to the amateur coil-maker. After considering briefly the theory of induction, he gives directions how to construct spark-coils, devotes a chapter each to Accessories to Coils, and special forms of coils. Some of the other chapters are Batteries for Coils, Repair of Batteries and Coils, and Useful Notes on Coils. He also devotes a chapter to some of the famous coils, such as that constructed for Mr. Spottiswoode by Apps, of London. The book is provided with a general index, and is quite fully illustrated.

THE ECONOMY OF HIGH WAGES. By J. SCHOENHOF. New York: G. P. Putnam's Sons, 1892. Pp. 414. Price, $1.50.

IN a time like the present, when a campaign of education on the tariff question is in progress, and when not only the great mass of the people, but many of the supposed beneficiaries of the tariff, are awakening to the fact that prosperity by taxation is not quite what it is represented to be, a book like the present one is a very welcome addition to the current literature of the subject. The protected classes have succeeded in maintaining themselves in the enjoyment of their present gratuities by their appeals to the workingmen to support protection as the sole guarantor of high wages. Protectionists have never tired of contrasting the day rate of wages in this country and Europe, claiming that they were due to the tariff, and that, if American manufacturing industries were deprived of the benefits of protection, wages must fall. In all their discussions of wages they have assiduously represented that the difference in wages corresponded with the difference in labor cost of the goods made here and abroad. It has been pointed out a good many times by tariff reformers that high wages do not necessarily mean high cost of production, but no one has heretofore taken up the question and dealt with it in such detail as the author of the present work. Mr. Schoenhof is peculiarly well fitted to undertake his task. He was commissioned by the late Secretary Bayard to make a study of the question in the trade and manufacturing centers of Europe while in the diplomatic service under the Cleveland administration, and has himself had an extended experience as an employer of labor. He not only controverts the proposition that a high rate of day wages necessarily means a high labor cost in production, but maintains that a high rate of wages is necessarily associated with a low labor cost of the goods. High wages mean high efficiency of the worker and low wages low efficiency, and the essential condition of the payment of high wages is that the worker is so much more efficient and has the command of so much better tools that he can produce goods more cheaply. Our high-priced American labor, therefore, has nothing to fear from the cheaper labor of England, and the relatively high-priced labor of England nothing to fear from the low-priced labor of the Continent. The real cheapness of high-priced and therefore efficient labor, when measured in commodities produced, which is the only consideration that has any bearing on the question of the competition of producers, can be readily apprehended and arrived at deductively. Mr. Schoenhof does not content himself, however, with an argument, but examines in detail the chief trades and industries of the world, finding that everywhere a high rate of wages and a low labor cost in production go hand in hand. He gives schedules in the pottery, glass, iron, cotton, and woolen industries,

abundantly proving his position, and shows very clearly that, so far from the workingman profiting by protection, he is injured at every turn. It is much to be hoped that the essential contention of the book can be properly brought before the farmers and artisans of the country while attention is so keenly alive to the importance of tariff questions. Tariff reformers will find ready to their hand in its pages just the kind of material needed to illustrate and enforce their positions, and should make good use of it in the opportunities afforded by present political discussions.

FRAGMENTS OF SCIENCE. By JOHN TYNDALL. In two volumes. New York: D. Appleton & Co., 1892. Pp. 452 each volume.

THE original volume under this title issued some twenty years ago has gradually grown in size by the addition of new papers until it finally became so unwieldy as to necessitate dividing it into two volumes. Besides the matter in the previous edition there are some fifteen new papers, mostly relating to researches in molecular physics. The present volume and the volume recently issued under the title of New Fragments contain, the publishers state in an introductory note, all of the occasional papers which Prof. Tyndall cares to preserve in a permanent form. The first of the present volumes contains the papers that relate to the laws and phenomena of matter solely; while the second, with the exception of the address upon the electric light, deals with questions which traverse the domain of mind as well as of matter. This volume contains the celebrated Belfast address delivered before the British Association at its Belfast meeting in 1874, as well as Prof. Tyndall's reply to various critics which he issued under the title of An Apology. The volume contains also the well-known address upon the Scientific Use of the Imagination, and that upon Matter and Force, as well as his excursion into fields considered by theologians especially their own, in which he discusses miracles and prayer in relation to natural laws.

It is not necessary at this late day to say anything in commendation of Prof. Tyndall's exposition of science. He is read wherever the English language is spoken, and comes perhaps in closer intellectual and emotional contact with his readers than any other scientific man of our time. This is due in large measure to that transparent intellectual honesty which makes him scorn to be self-deceived or to take any lower aim than the pursuit of truth, lead whither it will. There is, moreover, an elevation of moral tone pervading all his speculations concerning that unknown world into which we vainly peer, which brings him into sympathetic contact with all earnest seekers after truth, no matter how widely they differ in their conclusions. Of the literary merit of the discourses of Prof. Tyndall it is also needless to speak. The purity and vigor of his diction have always charmed his readers as much as his lucidity of thought, and he has long been recognized as one of the masters of style. Those who prize his writings will be glad to have them in this last form, which in all probability will prove to be a final one.

LIFE IN MOTION, OR MUSCLE AND NERVE. By JOHN GRAY MCKENDRICK. London and Edinburgh: A. & C. Black, 1892. Pp. 200. Price, $1.50.

THIS little book consists of a course of six lectures delivered before a juvenile audience at the Royal Institution, and is an excellent example of what a popular exposition of a scientific subject should be. Though addressed to juveniles, the lectures can be read with interest and profit by older folk who are not specially informed on physiological subjects and the methods and apparatus used by experimenters in studying the problems to which they address themselves.

The title Prof. McKendrick has given to his course is not a very happy one, as it does not indicate with any clearness the subject-matter of the lectures, which deal with muscular movement. He uses in his demonstrations the muscle of the frog which correponds with that of the calf of the leg in man. This he excites by means of an electric current, and performs a number of the striking and beautiful experiments devised by physiological experimenters for the study of the behavior of living matter. He illustrates by experiment the lifting power of a muscle when contracting; the nature of the movement that occurs when a muscle is contracting; shows graphically by means of curves on smoked glass the times of contract-

ing and relaxing, and the time required for nerve transmission; discusses the chemical changes that take place in a muscle when working and its analogy to a heat engine; and, after showing that a muscle generates an electric current, closes his course with a consideration of the electric organs found in certain fishes.

ELEMENTS OF QUALITATIVE AND QUANTITATIVE ANALYSIS. By G. C. CALDWELL, Ph. D. Second edition, revised and enlarged. Philadelphia: P. Blakiston, Son & Co. Pp. 175.

THE author, who is Professor of Chemistry in Cornell University, has brought together in this book the material that he has published before in handbooks of analysis, together with much new matter. The volume is divided into five parts: in the first of these the processes and manipulations of analytical chemistry are described quite fully; the second sets forth the systematic course of qualitative analysis; the third is devoted to the operations of quantitative analysis; directions for examples in quantitative analysis constitute part four; and lists of apparatus and reagents, various tables, etc., make up part five. This is the first book that we have seen to use the new spellings of chemical terms originated by the American Association for the Advancement of Science.

LIFE HISTORIES OF NORTH AMERICAN BIRDS. By CHARLES BENDIRE, Captain U. S. Army. Washington: Smithsonian Institution. Pp. 446, quarto.

THE Smithsonian Institution has begun a series of Special Bulletins, designed to illustrate the collections in the National Museum, and Captain Bendire's work, covering part of the collection of birds' eggs, appears as the first of the series. The present volume is confined to gallinaceous birds, pigeons, and birds of prey, embracing a total of one hundred and forty-six species and subspecies. Besides describing the eggs and nest, the author gives the breeding habits of each species, its migratory and breeding ranges, so far as these have been determined, and other facts of its life history. The classification given in the Code and Check List of the American Ornithologists' Union has been followed, and the synonymy and nomenclature used in this list have been adopted also. The value of the work is greatly enhanced by twelve elegant colored plates of eggs, embracing a total of one hundred and eighty-five varieties. Captain Bendire is Honorary Curator of the Department of Oölogy in the National Museum.

HISTORY OF HIGHER EDUCATION IN MASSACHUSETTS. By GEORGE GARY BUSH. Washington: Bureau of Education. Pp. 445.

THE best friend of Harvard University can not help seeing a great want of proportion in a history of Massachusetts colleges that gives more space to Harvard than to thirteen other institutions combined, yet this Prof. Bush's book does. The author gives a connected history of Harvard in his first three chapters, then describes the various departments of the university, tells how its instruction is given, sets forth the "formative influences" at Harvard which constitute student life, and closes with a sketch of the presidents of the college and university and a Harvard bibliography. Next comes a brief history of Williams College (chartered in 1793), by Eben Burt Parsons, D. D., secretary of the faculty. Then follow similar accounts of Andover Theological Seminary, Amherst College, Tufts College, Massachusetts Institute of Technology, Worcester Polytechnic Institute, and Boston College, by persons connected with the respective institutions. Accounts of Boston University, Massachusetts Agricultural College, and Clark University, compiled from official records, are also included. There are three histories of women's colleges—Mount Holyoke, Wellesley, and Smith—prefaced by a general chapter on Higher Education for Women, by Mrs. Sarah D. (Locke) Stow. The volume is well illustrated with plates, representing the buildings of the various colleges.

PHYSICAL EDUCATION IN THE PUBLIC SCHOOLS. By R. ANNA MORRIS. New York: American Book Co. Pp. 192. Price, $1.

THIS is a manual of gymnastics that may be performed in a school-room, some without any and some with simple apparatus. It provides for a graded course, extending from the first year of school to the high school. The movements are explained, and many are illustrated. There are directions for marching, which include a set of fancy

evolutions called the Irving School March Drill. An illustrated chapter is devoted to Delsartean posturing. Apparatus drills with wands, Indian clubs, rings, dumb-bells, etc., are described, and a great many additional evolutions are suggested. The volume includes thirty-two pages of music suitable for evolutions of classes. We are somewhat astonished to see in the front of the book a poetical quotation ascribed to Herbert Spencer!

MINERALOGY. By FREDERICK H. HATCH, F. G. S. New York: Macmillan & Co. Pp. 124. Price, $1.

THIS is a brief elementary manual consisting of two parts, the first devoted to characters of minerals, and the second being descriptive. In the first part the crystalline forms of minerals are described quite fully, and the chemical composition, specific gravity, and other characters are treated briefly. In the descriptive part the minerals are grouped under these heads: rock-forming minerals, ores and veinstones, salts and other useful minerals, gems or precious stones. The text is illustrated with many cuts showing the forms of crystals or amorphous minerals and the occurrence of minerals in veins.

A TREATISE ON HYGIENE AND PUBLIC HEALTH. Edited by THOMAS STEVENSON, M. D., and SHIRLEY F. MURPHY. Vol. I. Philadelphia: P. Blakiston, Son & Co. Pp. 1013.

THE extensive work of which the first installment is before us is made on the plan of having the several subjects included in its scope treated by authors having special qualifications for their respective tasks. In the selection of subjects the editors have been guided mainly by the needs of the English officials known as Medical Officers of Health, but there is much information in the essays which is applicable to sanitary conditions the world over. The first volume comprises sixteen essays dealing separately with air, water, food, clothing, baths, the dwelling, physical education, offensive and noxious businesses, etc. The most space is given to the treatise on The Dwelling, by P. Gordon Smith and Keith D. Young. The authors deal with the subjects of site, the arrangement of laborers' dwellings, prisons, barracks, schools, workhouses, and hospitals, both general and special, and the drainage of the dwelling. The Disposal of Refuse is also treated with much fullness in a separate article by W. H. Corfield, M. D., and Louis C. Parkes, M. D. In the essay on Warming and Ventilation, the author, W. N. Shaw, F. R. S., gives formulas and describes methods for calculating the movement of air in various systems of ventilation, and gives a summary of the conditions to be satisfied to secure a proper change of air. He also compares the efficiency of the ordinary modes of heating, and gives various numerical data concerning heating in the climate of England. The volume is illustrated with nearly two hundred cuts and plates, and has a separate index.

ANIMAL COLORATION. By FRANK E. BEDDARD, M. A., F. R. S. E. New York: Macmillan & Co. Pp. 288. Price, $3.50.

MR. BEDDARD has chosen a very attractive topic, and has made a book interesting to both the zoölogist and the general reader. After an introductory chapter giving the principal facts of animal coloration, he cites a number of cases in which the coloration of an animal appears to be in part due directly to the influence of the surroundings, among which are the prevalence of green in the animals of verdant Ceylon, the white fur of polar animals, and the absence of color among cave-dwelling species. Coming to the purposes of color in animals, the author finds much to discuss under the head of protective coloration. While on this subject he raises the question whether as a matter of fact animals are concealed from their foes by their protective resemblances, and shows that there is much evidence on the negative side. He contends, also, that in some cases so-called protective coloration is produced more simply and directly than by the operation of natural selection. Warning coloration, first explained by Mr. Wallace, next receives attention. The author is inclined to give much weight to the suggestion of Dr. Eisig that in caterpillars which are distasteful to their enemies the usual bright pigments cause the inedibility of the species instead of being produced to advertise it. Alluring colors receive attention in the same chapter. Allied to coloration like the surroundings is mimetic coloration or resem-

blance of one species to another that is better endowed with means of defense, or with some other desirable possession. Mr. Beddard frequently cautions investigators against proceeding as if the sight or taste of animals were the same as that of man, for in the questions here discussed the point of view is important. The volume closes with an account of the chief differences in coloration between the sexes of animals, and a statement of the leading theories proposed to explain them. The text is illustrated with four colored plates and thirty-six woodcuts.

NATURAL HISTORY LESSONS. Part I, Shelter, Food, and Clothing. By GEORGE ASHTON BLACK. Part II, Plants and Animals. By KATHLEEN CARTER. New York: Henry Holt & Co. Pp. 98. Price, 54 cents.

SCIENCE is rapidly acquiring the means for teaching its great pedagogical lesson that most knowledge may be obtained better from the study of things than from the study of books. This little manual is such a means. The first part of it is adapted to children of the usual primary-school age, and the second part to those in grammar-school grades. Its method requires constant practice in observation and investigation upon the objects and processes studied or upon pictures of them, thus giving the child at the outset of his education a thorough grounding in the natural way of acquiring knowledge. Prang's Lithographs of the Trades and Mr. Calkins's Manual accompanying them are expected to be used where the actual operations can not be witnessed.

BULLETIN OF THE PHILOSOPHICAL SOCIETY OF WASHINGTON, VOL. XI. Pp. 618.

THE presidential addresses delivered before the Philosophical Society in 1888, 1889, and 1890, together with thirteen papers on special scientific topics, form the body of this volume. With these are printed the minutes of the society and of the Mathematical Section for 1888 to 1891, the rules and lists of officers and members of the society. Among the papers is one on The Observation of Sudden Phenomena, by Prof. S. P. Langley, in which is described a mechanism for lessening the error in observation represented by the "personal equation." Prof. F. W. Clarke has a paper on The Relative Abundance of the Chemical Elements; another is by Everett Hayden on Hurricanes in the Bay of North America; and John R. Eastman has a record of The Progress of Meteoric Astronomy in America, containing important catalogues of meteorites and meteoric showers. As the subject of his presidential address in 1891, Major Clarence E. Dutton took the practical matter of Money Fallacies. The Evolution of Serials published by Scientific Societies is traced by W J McGee. The other papers deal with various technical matters.

FLORIDA, SOUTH CAROLINA, AND CANADIAN PHOSPHATES. By C. C. HOYER MILLAR. New York: The Scientific Publishing Co. Pp. 223. Price, $2.50.

THE practical and commercial side of phosphate mining occupies almost the whole of this volume, although it is supplemented by some notes on the geology of phosphate deposits and numerous tables of chemical analyses. The raising of phosphates from the beds of streams, the mining of pebble-deposits and of rock phosphates are described briefly, and copious information is given in regard to transportation, freights, prices, cost of production, companies engaged in the business, and similar matters connected with the industry. About half the volume is devoted to the Florida operations, South Carolina and Canada dividing the other half between them. An appendix contains analyses of a variety of foreign phosphates.

Under the title *Cardiac Outlines* a manual for physicians has been prepared by *William Ewart*, M. D. (Putnams). It is devoted to the physical examination of the heart and the recording of the results of such examination. The mode of recording the observations advised is by means of diagrams, in various parts of which are arrows to be crossed out if the sounds for which they stand are absent. There are fifty-two figures, and several leaves bearing the diagram referred to are bound into the volume.

A handsome manual of directions for *Leather Work* has been prepared by *Charles G. Leland*, whose manuals on several other minor arts are well known (Macmillan & Co. $1.50). It is eminently practical, beginning with a description of tools and materials and

describing one style of work after another, from the simplest to the most elaborate. The text is illustrated with over fifty figures of patterns, many of them representing work executed during the middle ages. There is also a special chapter on patterns and design. Directions for gilding are included in the volume and there is a suggestive list of articles that may be made of leather. The mechanical work of the volume is tasteful and appropriate, the leather cover being stamped with a design by the author.

Rev. *Henry C. Kinney*, an Episcopal missionary at the Chicago stock-yards, has published a pamphlet entitled *Why the Columbian Exposition should be opened on Sunday.* It is a vigorous plea in behalf of the workingmen who could not visit the fair on any other day of the week, and undertakes to prove that Sunday opening would not be irreligious nor in conflict with the Illinois statute, nor lead to any of the consequences that many pious persons dread.

The *Treatise on Diseases of the Nose* prepared for physicians two years ago by *Greville Macdonald*, M. D. (Macmillan, $2.50), has already reached a second edition. It consists of descriptions of the diseases of the nose and its accessory cavities, and the methods of treatment which the author has found advisable. A considerable number of instruments designed for nasal surgery are described and figured. There are also cuts and a colored plate representing morbid growths in the nose. In the second edition a number of important additions and modifications have been made.

Part XXII of the *Proceedings of the Society for Psychical Research*, July, 1892, contains five papers. In the first, On Indications of Continued Terrene Knowledge on the Part of Phantasms of the Dead, F. W. H. Myers gives cases in which an apparition has seemed to the person seeing it to act as if the dead person whom it represented had a remembrance of the events of his life, and other cases in which persons in a trance have gained knowledge that they did not have before. Mr. Myers will perhaps show later how any information as to the knowledge possessed by the dead can be gained from the workings of the minds of the living. The second paper is an account by Richard Hodgson of Mr. Davey's Imitations by Conjuring of Phenomena sometimes attributed to Spirit Agency. The conjuring includes some wonderful slate-writing and materializing tricks, and is valuable material for those who wish to combat the spiritualistic superstition. Miss R. C. Morton contributes a Record of a Haunted House, in which the main narrative is well supported by independent accounts. The third of Mr. Myers's papers on The Subliminal Consciousness follows. Its special topic is The Mechanism of Genius, and it deals largely with mathematical prodigies. The concluding paper is a supplement to Dr. Backman's experiments in clairvoyance previously published.

The society is represented in America by Richard Hodgson, 5 Boylston Place, Boston.

A very full manual of *Directions for Collecting and Preserving Insects* has been prepared for the National Museum by Dr. *C. V. Riley.* In these directions the apparatus is first described, and the student is then told how to collect in the four seasons of the year, how to find insects under stones, in rotten stumps, in living trees, and on sandy places, how to take insects of the several orders, etc. Then follow directions for killing and preserving insects, for preparing and mounting them, for the preservation of alcoholic specimens, for labeling and arranging collections, and for protecting them against museum pests and mold. Other subjects on which information is given are insect boxes and cabinets, the rearing of insects, and packing and transmitting specimens; directions for collecting arachnids and myriapods are given also. The manual is introduced by an account of the classification of the hexapods, in which some forty species are figured, and concludes with a list of the entomological works most useful to the student. The whole number of illustrations is one hundred and thirty-nine.

One of the Bulletins of the United States Geological Survey recently issued, No. 76, is of much popular and practical interest. It is the second edition of a *Dictionary of Altitudes in the United States*, compiled by *Henry Gannett*, the first edition of which was published in 1884. The present work is considerably enlarged, mainly by the addition of determinations of altitudes by railroads, so that the volume now contains 393 pages.

A monograph on *The Humming-Birds*, forming part of the Report of the National Museum, for 1890, has been prepared by *Robert Ridgway*. It comprises a general zoölogical account of this group of birds, followed by descriptions of the several species found in the United States. The text is illustrated by forty-six plates and about fifty cuts.

An ingenious system of writing, signaling, and cryptography, to which he has given the name *Cosmography*, is described in a small pamphlet by *Charles G. Burke* (124 Nassau Street, New York). On a scale of three horizontal lines, using a dot, two slanting and one vertical marks, any language having not more than twenty-eight letters may be written in cosmography. The dot and three marks, if placed below the first line of the scale, stand for *a*, *d*, *c*, and *b* respectively; if on the first line, they stand for *e*, *h*, *g*, and *f*, and so on. In telegraphing, one, two, three, and four dots may take the place of the characters, and one, two, and three dashes may indicate the lines. An instrument consisting of a lettered dial with arms, called the "cosmograph," embodies the system in a mechanical form.

The *First Book of Electricity and Magnetism* (Macmillan & Co.) is designed to precede the usual elementary text-books in this study. The author, *W. Perren Maycock*, has felt the need as a teacher of interesting beginners, who are often discouraged by technical language. The subject of the magnet is entered upon at once; the explanations are clear, simple, and fully illustrated. Other divisions of the work besides magnetism are: electricity in motion, and electricity at rest. An index, list of apparatus, and blank pages for notes are furnished, as well as questions for teachers.

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Brooklyn Ethical Association. Man and the State. Studies in Applied Sociology. New York: D. Appleton & Co. Pp. 558. $2.

Brooklyn Institute of Arts and Sciences. Prospectus for 1892–'93. Pp. 40.

Bryant, William M. A Syllabus of Psychology. Chicago: S. C. Griggs & Co. Pp. 60. 25 cents.

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Chadwick, Rev. John W. Education as related to Citizenship. D. Appleton & Co. Pp. 24. 10 cents.

The College Fraternity. E. H. L. Randolph, Editor. New York: Fraternity Publishing Co. Monthly. Pp. 82. 25 cents. $2 a year.

Daudet, Alphonse. L'Evangéliste. Translated by Mary Neal Sherwood. New York and Chicago: F. T. Neely. Pp. 304. 50 cents.

Day, David T. Mineral Resources of the United States. U. S. Geological Survey. Pp. 671.

De Varigny, Henry. Experimental Evolution. Macmillan & Co. Pp. 270. $1.50.

Dobbin, Leonard, and Walker, James. Chemical Theory for Beginners. Macmillan & Co. Pp. 240. 70 cents.

Drake, Jeanie. In Old St. Stephen's. D. Appleton & Co. Pp. 232. 50 cents.

Dumble, E. T., State Geologist. Third Annual Report of the Geological Survey of Texas. Austin. Pp. 410, with Maps.

Emerson, James, Willimantic, Mass. Treatise relative to the Testing of Water-wheels and Machinery. Pp. 480. $1.

Fallon, W. H., and Hobbs, E. C. Report of the North Dakota Weather Service for July, 1892. Bismarck. Pp. 16.

Fay, Joseph Story. The Track of the Norseman. Pp. 7.

Fouillée, Alfred. Education from a National Standpoint. D. Appleton & Co. Pp. 332. $1.50.

Harrington, Mark. Report of the Chief of the Weather Bureau for 1891. Washington. Pp. 100.

Hay, O. P. On the Ejection of Blood from the Eyes of Horned Toads. Pp. 10.—On the Breeding Habits, etc., of Certain Snakes. Pp. 13.

Hilgard, E. W. A Report on the Relations of Soil to Climate. Washington: Weather Bureau. Pp. 59.

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Horr, Hon. Roswell G. The Republican Party. D. Appleton & Co. Pp. 16. 10 cents.

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Humphry, J. E. Amherst Trees: An Aid to their Study. Amherst, Mass.: Carpenter & Morehouse. Pp. 78.—Fungous Diseases and their Remedies. Boston: Rockwell & Churchill. Pp. 15.

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Kimball, Rev. John C. Moral Questions in Politics. D. Appleton & Co. Pp. 38. 10 cents.

Lawrence, Judge William. The American Wool Interest. New York: American Protective Tariff League. Pp. 64. 6 cents.

Le Conte, Joseph. The Race Problem in the South. D. Appleton & Co. Pp. 56. 10 cents.

Lodge, Oliver J. Lightning Conductors and Lightning Guards. Macmillan & Co. Pp. 544. $2.

McDonald, Marshall, U. S. Fish Commissioner. Report respecting the Establishment of Fish-cultural Stations in the Rocky Mountain Region and Gulf States. Washington. Pp. 88, with Plates.

Maclean, John. The Destiny of the Human Race. Port Arthur, Ont. Pp. 20.

Mahan, Captain E. T. Admiral Farragut. D. Appleton & Co. Pp. 333, with Portrait and Maps. $1.25.

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Wilcox, Ella Wheeler. Sweet Danger. Philadelphia: F. T. Neely. Pp. 296. 50 cents.

Williams, J. W. Hume. Unsoundness of Mind, in its Legal and Medical Considerations. New York: William Wood & Co. Pp. 179.

Wright, G. Frederick. Man and the Glacial Period. D. Appleton & Co. Pp. 385. $1.75.

POPULAR MISCELLANY.

Reality of Geological Catastrophes.—In a review of the history of the theories of the development of the earth's crust—that of uniformitarianism and that of catastrophes—in his address at the British Association, Prof. Archibald Geikie spoke of a modification or enlargement of the uniformitarian doctrine which has been brought about by continued investigation of the terrestrial crust and consequent increase of knowledge respecting the history of the earth. "Though Hutton and Playfair believed in periodical catastrophes, and indeed required these to recur in order to renew and preserve the habitable condition of our planet, their successors gradually came to view with repugnance any appeal to abnormal, and especially to violent, manifestations of terrestrial vigor, and even persuaded themselves that such slow and comparatively feeble action as had been witnessed by man could alone be recognized in the evidence from which geological history must be compiled. Well do I remember in my own boyhood what a cardinal article of faith this prepossession had become. We were taught by our great and honored master, Lyell, to believe implicitly in gentle and uniform operations, extended over indefinite periods of time, though possibly some, with the zeal of partisans, carried this belief to an extreme which Lyell himself did not approve. The most stupendous marks of terrestrial disturbance, such as the structure of great mountain chains, were deemed to be more satisfactorily accounted for by slow movements prolonged through indefinite ages than by any sudden convulsion. What the more extreme members of the uniformitarian school failed to perceive was the absence of all evidence that terrestrial catastrophes even on a colossal scale might not be a part of the present economy of this globe. Such occurrences might never seriously affect the whole earth at one time, and might return at such wide intervals that no example of them has yet been chronicled by man. But that they have occurred again and again, and even within comparatively recent geological times, hardly admits of serious doubt. How far at different epochs and in various degrees they may have included the operation of cosmical influences lying wholly outside the planet, and how far they have resulted from movements within the body of the planet itself, must remain for further inquiry. Yet the admission that they have played a part in geological history may be freely made without impairing the real value of the Huttonian doctrine, that in the interpretation of this history our main guide must be a knowledge of the existing processes of terrestrial change."

Physiological Action at a Distance.—Discussing the cause of physiological action at a distance, in the British Association, Prof. Errera, of Brussels, said that most vegetable organs were sensitive to the influences of the environment, and responded to these stimuli, as long as they were

capable of growth, by bending in different directions—phenomena familiar to vegetable physiologists. But two years ago other phenomena were observed, which did not appear to belong to any of the known categories. Elfving found that pieces of iron and, to a less degree, of zinc or aluminium, as well as different organic substances, such as sealing-wax, rosin, etc., attracted the growing sporangium-bearing filaments of a mold (*Phycomyces nitens*). All other metals Elfving found inactive, but the filaments of the mold itself showed a mutual repulsion. This movement, however, Prof. Errera considered wholly due to the hygroscopic condition of the stimulatory substance. The sensibility of phycomyces, he observed, was in fact so great that it might be used as a reagent to test the existence of hydroscopic power, which he illustrated in the case of camphor, the hydroscopic condition of which, after one experiment, was proved by careful weighing, although it was unknown to chemists. All the experiments succeeded in a saturated atmosphere, showing that hydrotropism was not due, as generally believed, to difference in the hygrometric state of the air. To sum up, concluded the author, the apparently mysterious action of iron on phycomyces was nothing but a matter of hydrotropism, and hydrotropism itself, negative or positive, was the bending of a vegetable organ toward the points, not where it would find a minimum or maximum of moisture, but where it would transpire most or least.

Disappearance of Wild Plants.—The report of the committee of the British Association on the disappearance of wild plants from their native habitats mentioned fifty of the less common wild plants of the west of Scotland which had been greatly reduced in number in recent years from natural and other causes. The natural causes were due to agriculture, drainage, industry, and the growth of towns and villages, and seemed to be outside of the scope of protective measures. In many cases disappearance is attributable to the removal of specimens by collectors for the formation of herbariums, and of plants with showy flowers and ferns for sale. Herbariums are essential to the study of botany, but the committee thought their multiplication might be made unnecessary by the formation of local collections for reference. Collections for sale might be prevented by the intervention of proprietors. But it was difficult to suggest any course of prohibitive measures. In the discussion the too specific designation of places where choice plants can be found was deprecated as making access to them too easy to unscrupulous searchers. A resolution was passed on the preservation of birds and eggs; and Canon Tristram, speaking to it, put in a plea for the preservation of birds of prey, pointing to the mice-plague in Dumfries and Lanark shires as a result of destroying the balance of Nature by wholesale killing of such birds.

Prize Essays on Alcohol.—The American Medical Temperance Association, through the kindness of J. H. Kellogg, M. D., of Battle Creek, Mich., offers the following prizes:

1. One hundred dollars for the best essay On the Physical Action of Alcohol, based on Original Research and Experiment.

2. One hundred dollars for the best essay On the Non-Alcoholic Treatment of Disease.

These essays must be sent to the secretary of the committee, Dr. Crothers, Hartford, Conn., on or before May 1, 1893. They should be in type-writing, with the author's name in a sealed envelope, with motto to distinguish it. The report of the committee will be announced at the annual meeting at Milwaukee, Wis., in June, 1893, and the successful essays read. These essays will be the property of the Association, and will be published at the discretion of the committee. All essays are to be scientific, and without restrictions as to length, and limited to physicians of this country. Address all inquiries to T. D. Crothers, M. D., secretary of committee, Hartford, Conn.

Devolution of the Little Toe.—The thumb and great toe of men are two-jointed, while the other fingers and toes are three-jointed. But it has been observed, in the examinations of skeletons, that the little toe is occasionally two-jointed; the middle and terminal phalanges having been so united that they can hardly be distinguished. This variation occurs in about thirty-six per cent

of the cases, and usually affects both feet alike, but appears rather more frequently in women than in men. Pressure of the shoes has been assigned as a cause of it, but it has been observed in children under seven years old, and even in embryos as often as in adults, and in circles where tightly fitting shoes are not worn. Dr. Pfitzner, who has made a special study of the subject, has come to the conclusion that the little toe is in process of degeneration, and that without its being possible to show that it is suffering an adaptation to any external mechanically operating influence. Corresponding to this, certain processes of reduction are going on in the muscular apparatus. The whole phenomenon is of interest, because we are witnessing its beginning, and can certainly predict its outcome in the final reduction of the little toe to two joints.

The Exact Point of the Pole.—If any of our arctic explorers ever reach the pole, they will be confronted by a very difficult problem in determining the exact point. Geographical determinations increase in difficulty on approaching the pole, on account of the narrowing of the degrees of longitude, and the compass, sextant (if the weather is cloudy), and chronometer are of little use then. A process for taking the point at the pole has been described by M. E. Durand Gréville, which depends on the properties of the gyroscope. The apparatus consists of two gyroscopes and a plumb-line. To determine the latitude a gyroscope which has been oriented by its axis to the pole of the sky — or a gyroscope-compass — is employed. The angle which its axis makes with the vertical of the place is complementary to the latitude. To determine the longitude, a second gyroscope is needed, which has been adjusted so as to turn in a plane parallel to the meridian of the point of departure. The plane of the gyroscope-compass being necessarily parallel to the equator, if we project the vertical of the place upon it, and measure the angle which that projection makes with the line of intersection of the planes of the two gyroscopes, we shall have the difference in longitude of the point of departure and the point of arrival. A practical arrangement for taking this measure has been devised by M. Trouvé. Before starting, the travelers set in motion the gyroscope-compass and the gyroscope whose plane is the meridian of the point of departure. When the position of a point is to be determined, the axes of the two gyroscopes are conveyed parallel to themselves, and the vertical of the point reached is taken with a plumb-line. If the axis of the gyroscope-compass is parallel to the plumb-line, the balloon is immediately above the pole. The result is not affected by height above the earth's surface, for the directions of the three instruments continue the same at all points of the same vertical.

Canadian Names and Places.—Dr. George M. Dawson observes, in his Geography of Canada, that throughout the country many of the original Indian names of places have been adopted and perpetuated by the whites, but in most cases they have suffered abbreviation or other changes in the process. In general the native names are found to be of a descriptive character, and to express some noted feature or product of each locality. Taking instances from different parts of the country and in several dialects, Nictau means "forks of a river"; Shediac, "running far back"; Matapedia, "roughly flowing"; Quebec, "a strait or an obstruction"; Toronto, "a tree in the water"; Winnipeg, "muddy water"; Saskatchewan, "rapid current." It is further noteworthy that in many cases the principal villages or places of resort of the Indians have since become the sites of towns or cities. This depends on the circumstance that the whites first sought such places for purposes of trade, but chiefly on the fact that the Indians selected localities where natural lines of travel, such as rivers, converged, or were interrupted by falls or rapids, necessitating portages; also such places as sheltered havens or harbors on the sea-coast or the shores of the Great Lakes.

Vegetation of New Guinea.—So great a wealth of botanical material has been collected in New Guinea that there are now as many of the higher plants of that country known to science as of German plants, or about two thousand. Inasmuch as the component parts of the forest change in extraordinarily short distances, it may be expected that at least three times as many species will

ultimately become known. The island has furnished such an abundance of important and prominent new types, that, as respects plant life, it may be regarded as one of the most interesting and beautiful parts of the earth. The close relationship often supposed to exist between the north Australian flora and that of New Guinea has not been confirmed. It is true that the savannas of the Fly River, covered with eucalyptuses, myrtaceæ, and proteaceæ, correspond not only in their outward habitus, but also in composition, with the formation of York Peninsula; but the typical Australian flora is quite foreign to New Guinea, and there is no ground for the supposition that the island was at one time inhabited by Australian species. The palm flora of the island is one of the richest in the world; almost every district is distinguished by endemic species. The age of the island must be very great; the large number of indigenous genera and species testify to this; of the former, at least fifty are already known.

Geographical Development of Coast-lines.—Summing up the points of his paper in the British Association on the Geographical Development of Coast-lines, Prof. James Geikie arrives at the general conclusion that the coast-lines of the globe are of very unequal age. Those of the Atlantic were determined as far back as Palæozoic times by great mountain uplifts along the margin of the continental plateau. Since the close of that period many crustal oscillations have taken place, but no grand mountain ranges have again been ridged up on the Atlantic seaboard. Meanwhile the Palæozoic mountain-chains, as was shown, have suffered extensive denudation, have been planed down to the sea-level, and even submerged. Subsequently converted into land, wholly or partially as the case may have been, they now present the appearance of plains and plateaus of erosion, often deeply indented by the sea. No true mountains of elevation are met with anywhere in the coast-lands of the Atlantic, while volcanic action has well-nigh ceased. In short, the Atlantic margins have reached a stage of comparative stability. The trough itself, however, is traversed by at least two well-marked banks of upheaval—the great meridional Dolphin Ridge, and the approximately transmeridional Farõe-Icelandic belt—both of them bearing volcanic islands. But while the coast-lands of the Atlantic proper attained relative stability at an early period, those of the Mediterranean and Caribbean depressions have up to recent times been the scenes of great crustal disturbance. Gigantic mountain-chains were uplifted along their margins at so late a period as the Tertiary, and their shores still witness volcanic activity. It is upon the margins and within the troughs of the Pacific Ocean, however, that subterranean action is now most remarkably developed. The coast-lines of that great basin are everywhere formed of grand uplifts and volcanic ranges, which, broadly speaking, are comparable in age to those of the Mediterranean and Caribbean depressions. Along the northeast margin of the Indian Ocean the coast-lines resemble those of the Pacific, being of like recent age, and similarly marked by the presence of numerous volcanoes. The northern and western shores, however (as in Hindostan, Arabia, and East Africa), have been determined rather by regional elevation or by subsidence of the ocean floor than by axial uplifts—the chief crustal disturbances dating back to an earlier period than those of the East Indian Archipelago. It is in keeping with this greater age of the western and northern coast-lands of the Indian Ocean that volcanic action is now less strongly manifested in their vicinity.

The Story which Scenery tells.—"The law of evolution," said Prof. Archibald Geikie at the British Association, "is written as legibly on the landscapes of the earth as on any other page of the book of Nature. Not only do we recognize that the existing topography of the continents, instead of being primeval in origin, has gradually been developed after many precedent mutations, but we are enabled to trace these earlier revolutions in the structure of every hill and glen. Each mountain-chain is thus found to be a memorial of many successive stages in geographical evolution. Within certain limits, land and sea have changed places again and again. Volcanoes have broken out and have become extinct in many countries long before the advent of man. Whole tribes of plants and animals have meanwhile come and gone, and in leaving their remains behind them as

monuments at once of the slow development of organic types and of the prolonged vicissitudes of the terrestrial surface, have furnished materials for a chronological arrangement of the earth's topographical features. Nor is it only from the organisms of former epochs that broad generalizations may be drawn regarding revolutions in geography. The living plants and animals of to-day have been discovered to be eloquent of ancient geographical features that have long since vanished. In their distribution they tell us that climates have changed, that islands have been disjoined from continents, that oceans once united have been divided from each other, or once separate have now been joined; that some tracts of land have disappeared, while others for prolonged periods of time have remained in isolation. The present and the past are thus linked together, not merely by dead matter, but by the world of living things, into one vast system of continuous progression."

House "Leader Pipes" as Lightning Rods.—Mr. W. H. Preece called attention in the British Association to a new danger in the destruction of lightning protectors by recent municipal legislation. He said that the immunity of private houses from being struck by lightning is very marked, and this is considered to be due to the fact that the lead on the roofs and the iron stack-pipes that drain these roofs, connected as they are together, form admirable lightning protectors. Any charge of atmospheric electricity which may fall upon a house so protected is conveyed harmlessly away to the earth. British householders are now required to remove these pipes from direct connection with the drains, and to leave an air-space between the end of the pipe and the grating of the drain. The result is that the electric conduction of the pipe is broken, the stack-pipe ceases to be a lightning protector, and houses are left exposed to the danger of atmospheric electricity. The remedy is very simple. The pipe need not be entirely cut away. Three fourths of its circular section may be removed for the distance required, and one fourth may be left to maintain the old electrical connection; or, if the separation has been effected, then the stack-pipe should be connected with the drain by a wire or rod so as to restore a path for the charge to the earth. Householders are also now compelled to put up stack-pipes to ventilate their soil-pipes, erecting above their roofs a metal tube forming a prominent object exposed to the atmospheric charge, and terminating frequently in an earthenware pipe on the first floor. They are thus liable to be struck by lightning without being offered any means of escape. The tubes should be connected electrically with the earth either directly or indirectly through the stack-pipes, which would then make them sources of safety rather than of danger.

A Haida Indian Pole-raising.—The *keeang* poles of the Haida Indians of the Queen Charlotte Islands, according to Mr. Alexander Mackenzie's account of them, were erected to commemorate the event of a chief taking position in the tribe by building a house and making a distribution of all his property. Each pole has also an individual and distinguishing name. Thus, one of the poles at Masset is named Que-tilk-kep-tzoo, meaning "watcher for arrivals" or "looking" or "watching for arrivals." It was erected by a Haida chief named Stultah, on his decision to build a new lodge. The occasion, as usual, was marked by a large distribution of property, hundreds of blankets and other valuables being given away to all who assisted at the making of the pole, or who were invited to the ceremony. When it was decided to erect a *keeang* and build a lodge, invitations were sent to the tribes in the vicinity to attend, and on arrival the people were received by dancers in costume and hospitably treated and feasted. When all the Indians from adjacent places were assembled, at the appointed time they proceeded to the place selected for the erection of the pole. A hole seven, eight, or ten feet deep having been dug, the pole was moved on rollers till the butt was in a proper position to slip into it. Large ropes were fastened to the pole and gangs of men, women, and children took hold of the ends at a considerable distance away. The most able-bodied men advanced to the pole, standing so close all along on each side that they touched each other, and grasping the pole from underneath they raised it up by sheer strength, by a succession of lifts, as high as

their heads, while others placed supports under it at each successive lift. Stout poles tied together like shears were then brought into play, while the lifters took sharp-pointed poles, about eight feet long, and standing in their former positions, lifted the pole (which was immediately supported by the men with the shears) by means of these sticks, until it attained an angle of about forty-five degrees. The butt was then gradually slipped into its place and the gangs at the ropes, who had been inactive all this time, got the signal to haul, when, amid the most indescribable bellowing, hallooing, and yelling, the pole was gradually and surely elevated to the perpendicular position. When the setting was completed, the crowd adjourned to the house of the owner, who feasted the people, and afterward took the place of Eitlahgeet, great chief. Next he distributes his property, a task requiring great discrimination. Often he adopts a new name. When he proclaims to the crowd that he is quite impoverished and has distributed all his effects, they appear to be delighted, and regard him as indeed a great chief.

The Races of Peru.—According to Señor F. A. Pezet, the aboriginal or Indian race which populated Peru, 12,000,000 souls strong when the Spaniards conquered the country, still holds its own, although it has to a great extent degenerated through the miseries which, during centuries, it endured at the hands of its conquerors. It represents to-day about fifty-seven per cent of the entire population. In the interior of Peru it has kept in many places quite pure, not having mixed with any of the other races that have been brought into the country. There are tribes existing to-day with the old Inca Indian features quite distinct, and among these people there is a great and natural intellect. The other great race is the European, or white, imported from Spain at the time of the conquest, which has ever been on the increase since then. It represents to-day about twenty per cent of the population, and is spread over the whole country, but particularly on the coast. As the Peruvian Indian was made to slave at the mines for his Spanish master, the Spaniards had to introduce Africans to till the ground and work on the cotton and sugar estates along the coast. No Africans have come to the country since slavery was abolished in 1854, and the race has been confined to some of the agricultural districts, and is now rapidly dying out. In its place are the "mestizo" and "zambo," cross-breeds of blacks with whites and with Indians. The cross-breed of whites with Indians has produced the "cholo" race, which of all castes is to-day the most numerous. These mixed races represent about twenty-three per cent of the whole population. Of some fifty thousand Chinese imported since 1854, to be agricultural laborers, the greater part have settled for good, and not a few have embraced the Christian faith and married with Indians, cholos, zambos, mestizos, blacks, and whites, thereby forming a diversity of castes.

Ventilation at the Top and at the Bottom of Rooms.—The impression, which is very common, and is even held by engineers, that impure air, on account of its superior weight, accumulates to excess in the lower parts of rooms, while the upper parts are free from it, and that ventilation should be applied near the floor rather than near the ceiling, is controverted in the Sanitarian by Dr. W. H. Thayer. The property of gases to diffuse and intermix with one another, irrespective of relative densities, is lost sight of by these authorities. Dr. Thayer finds that the carbonic-acid gas of respiration and illumination will eventually be equally diffused through the atmosphere, although it is retained at the upper part of a room as long as the high temperature continues; and that it never, under any circumstances, is precipitated in excess in the lower part of the room. This conclusion, partly drawn from the philosophy of the matter, has been amply verified by experiments. Dr. H. Cresson Stiles, of the Metropolitan Board of Health, having analyzed the air of many public schools, hospitals, theatres, and churches, found the air taken from near the ceiling always more highly charged with carbonic acid than that in the lower parts of a room, with the difference often very marked. St. Ann's Church, Brooklyn, which was ventilated on the "bottom ventilation" theory, was found to be badly ventilated, with the carbonic acid in the gallery at the close of the service in larger quantity than near the floor. The

ventilation of the hall of the old Brooklyn Institute was nearly perfect, and was all through large openings in the ceiling.

Life on Mount Roraima.—Mount Roraima, in British Guiana, which was first ascended in 1884 by Mr. Everard Im Thurm, was again climbed in November, 1891, by Mr. E. Cromer and Mr. Seyler, two collectors of orchids. Exploring the top, the adventurers found toward the south many gigantic and marvelously shaped rocks that seemed to form, as Mr. Cromer described them, "majestic palaces, churches, and fortresses." Other smaller rocks resembled pyramids, umbrellas, and kettles, and one bore a striking likeness to the statue of a man. Between these grotesque masses of rocks were innumerable lochs, some joined together by canals, most of which were shallow, although here and there a depth of six feet was found. Many new species of orchids and other plants were found; but the mountain-top seemed almost destitute of animal life. Mr. Cromer noticed one black butterfly, a few spiders, some small frogs, some small lizards, and a small, dark-colored mammal, which he supposed was a species of kibihee, and on his approach gave a sound like a whistle, and swiftly crept into a hiding-place between the rocks. The lakes on the summit, which cover a considerable area, were swarming with a sort of black beetle. Mr. Cromer and his companion are the first men who have stayed a night on the top of Roraima.

The Mentone Skeletons.—The grottoes of Baussé Roussé, or of Mentone, as they are commonly called, are nine in number, and seven of them were inhabited by Quaternary man. M. E. Rivière, who owns them, explored certain of them in 1872, 1873, and 1875, and recovered several human skeletons and interesting relics from them. A second entry was made into one of them, the Barma Grande, last winter, during the owner's absence and without his knowledge, and several other skeletons and relics were obtained in it. Of the two which have been most fully excavated one is the skeleton of an old man, and the other of a young man of about eighteen years of age. They both appear to be of the Cro Magnon race, and are of fairly large stature. They were adorned with collars of sea-shells, bored for stringing, and of canine teeth of the deer, and vertebræ of fish (salmon and trout). The skeletons, shells, teeth, and vertebræ are all colored a curious red, dotted with bright points, which is derived from the dust of specular iron, with which the bodies of the adults were covered immediately after death. The arms and utensils found immediately in contact with the skeletons consisted of a cut flint seventeen centimetres long by fifty-one millimetres broad, which was situated behind the head of the old man, a scraper, and a curious article of bone or deer horn in the shape of a double ovoid, marked on the surface with numerous irregular and irregularly spaced striæ.

Distribution of Land-shells.—Land-shells, according to Mr. W. H. Dall's Instructions for collecting Mollusks, are found at all elevations, from the beaches moist with sea-spray to the Alpine heights of fourteen thousand feet in the vicinity of perpetual snow. Some are subterranean in their habits, pursuing earth-worms through their burrows, or nestling in the recesses of bones in ancient graveyards. Others are contented with the protection afforded by dead leaves, decaying logs, under the bark starting from rotten stumps, or in the shelter of loose stones and bowlders. Other groups live on the leaves of sedges, grass, and shrubbery, retreating to the soil for winter quarters; some highly colored species live permanently in the tree-tops of tropical forests. In arid regions they seek the shade of stones, attach themselves to the stems of cacti or other desert plants, or even adhere to the sunburned surfaces of rocks so hot as to be uncomfortable to the touch. The color of the shell bears a certain relation to its favorite station. The tree-living forms are brightest and most varied; the moss-lovers and terrestrial species are usually dull, horny, or greenish, but often have a brilliant, polished, or delicately sculptured surface; while subterranean forms are pale or pellucid. The slugs are generally nocturnal, and retreat to holes and crevices. In general, limestone regions are most favorable for land-shells, and those of flinty rock least advantageous. Woods of resinous trees are unsuited to their tastes, while soft woods of deciduous trees are congenial to them. Some

pungent herbs are noxious to them; but nettles are a favorite haunt of certain small land-shells. Spring is the most active season for snails; they attain their fullest development toward midsummer; and as winter approaches they penetrate the ground or in warm regions attach themselves to the bark of trees or to stones for a period of hibernation. They close the aperture of the shell with a leathery secretion, sometimes strengthened by more or less limy matter, or, if naked, may surround themselves with it like a cocoon.

Value of Scientific Amateurs.—Is it not true (asked Prof. Arthur Schuster in the British Association) that the one distinctive feature which separates England from all other countries in the world is the prominent part played by the scientific amateur, and is it not also true that our modern system of education tends to destroy the amateur? By amateur I do not necessarily mean a man who has other occupations and only takes up science in his leisure hours, but rather one who has had no academical training, at any rate in that branch of knowledge which he finally selects for study. We may, perhaps, best define an amateur as one who learns his science as he wants it and when he wants it. I should call Faraday an amateur. He would have been impossible in another country; perhaps he would be impossible in the days of the Science and Art Department. Other names will occur to you, the most typical and eminent being that of Joule. We are in danger of losing one great and necessary factor in the origination of scientific ideas. If I am right, there is a distinct advantage in having one section of scientific men beginning their work untrammeled by preconceived notions, which a systematic training in science is bound to instill. If school examinations could be more general, if scientific theories could only be taught at an age when a man is able to form an independent judgment, there might be some hope of retaining that originality of ideas which has been a distinctive feature of this country, and enabled our amateurs to hold a prominent position in the history of science. At present a knowledge of scientific theories seems to me to kill all knowledge of scientific facts. It is by no means true that a complete knowledge of everything that has a bearing on a particular subject is always necessary to success in an original investigation. In many cases such knowledge is essential, in others it is a hindrance. Different types of men incline to different types of research, and it is well to preserve the dual struggle.

What caused the Ice Age?—In their paper in the British Association on The Cause of the Ice Age, Messrs. P. F. Kendall and J. W. Gray maintain that the Glacial period came on with extreme slowness; that it was of long duration; that it passed away very abruptly and very recently, probably about ten thousand years ago; and that the geological record, though yielding evidence of ancient glaciers, yet was without trace of any previous Glacial period. They criticised the existing theories of the cause of the Ice age, and urged that the ingenious theory of Croll was objectionable upon several grounds. It was linked with a chronology which, even with the reservations made by Sir Robert Ball, was not reconcilable with geological facts. It involved the occurrence of repeated Glacial periods, and accounted neither for the very gradual approach nor the very abrupt departure of the cold. The theory of Mr. Upham, of the United States Geological Survey, that a great series of continental uplifts had raised enormous areas of the Northern Hemisphere above the snow-line, was based on evidence valid in itself, but failed to prove that the uplift was synchronous or coincided with the Glacial period. Further, there was irrefragable evidence that the British Isles stood at almost absolutely the same level as at present. Enormous ice-sheets swathed the whole of the northern and western portions of Britain. An explanation which would not apply to the British Isles might safely be rejected. The authors, although they formulate no theory of their own, invite the attention of astronomers to the suggestion that as the sun has undergone a secular cooling such as the president, Sir Archibald Geikie, declared in his address had happened to the earth, the Glacial period was a consequence of this cooling. This would perhaps account for the gradual refrigeration, leaving not the Ice age, but the genial period which suddenly supervened, to be accounted for. Varia-

tions in solar radiation by the operation of the same causes that produce sun-spots do beyond doubt occur; and the sudden blazing out of new stars, like that in Auriga, are facts which suggest almost unlimited possibilities of the rejuvenescence of suns. It may well be that the Glacial period is a phenomenon attendant upon the decrepitude of the sun, and the first of a series whose second term may be nearer at hand than geologists or laymen have previously suspected.

Depth of the Atmosphere.—Calculations based on the observation of the refraction of light have caused it to be supposed that the air becomes so rare at the height of about sixty miles that that distance may be regarded as the limit to its sensible extent; but other calculations, made during the present century, of the distance from the earth at which meteors ignite, indicate that the atmosphere extends to upward of a hundred miles. The question is thus presented, says M. Forster, in a paper on the subject, whether the incandescence of these meteors is caused by the resistance of an earthly atmosphere—that is, of oxygen and nitrogen moving with the earth—or is developed in an interstellar atmosphere. The fact that the aurora borealis reaches heights of about four hundred miles tells in favor of the latter hypothesis. The orbits of some comets and the satellites of Jupiter are subject to changes which can be explained only by the action of a resisting medium, and it would be desirable to determine from solar analysis whether the medium in which the aurora exhibits itself is differently composed from our atmosphere, either of gases emanating from the sun or those produced by the explosion of meteoric bodies. The luminous clouds, of which Mr. O. Jesse has made a special study, are objects of great importance in the study of the circulation of the upper atmospheric strata.

Cyrus W. Field.—Mr. Cyrus W. Field, who died at his summer home near this city, July 12th, will be best remembered for his agency in the laying of the Atlantic cables, by which methods of communication and of transacting business between this country and Europe have been revolutionized. Without him they would not have been put in operation for many years later than they were, if at all. Mr. Field was born in Stockbridge, Mass., in 1819, began his business life as a clerk in A. T. Stewart's store at one dollar a week, and at the end of his term of apprenticeship set up in business for himself as a junk-dealer and paper-maker. He became interested in submarine telegraphy in 1853, and induced a few capitalists to join with him in the Atlantic telegraph enterprise. After thirteen years of effort, fifty journeys across the Atlantic, and many failures, the lines were established, and Mr. Field received the honors that were his due. Several years afterward, Mr. Field engaged in the enterprise of building the elevated railroads in New York city, and materially contributed by his energy to their speedy completion.

National Characteristics in Science.—In his address before the Physical Section of the British Association Prof. Arthur Schuster spoke of the peculiarities possessed by each nation which make it better fitted than its neighbors to do some particular part of the work on which the progress of science depends. No country, for instance, has rivaled France in the domain of accurate measurement, with which the names of Regnault and Amagat are associated, and the International Bureau of Weights and Measures has its fitting home in Paris. The best work of the German universities seems to consist in the following up of some theory to its logical conclusions and submitting it to the test of experiment. The speaker doubted whether the efforts to transplant the research work of German universities into England will prove successful. Does it not seem well to let each country take that share of work for which the natural growth of its character and its educational establishment best adapt it? As far as the work of the Physical Section is concerned, the strongest domain of English students has been that of mathematical physics. Look at the work done in Great Britain during the last two centuries—the work not only in physics, but in astronomy, chemistry, and biology.

Cause of the Bursting of Peat-bogs.—The curious phenomena of the swelling and bursting of peat-bogs have been studied by Herr Klinge. They generally occur after heavy rains, and are preceded by detonations

and earth vibrations. A muddy stream issues from them, of varying fluidity, rolling along lumps of peat. Then the mud hardens and the bog sinks back, forming a funnel-shaped pool. The bogs studied by the author have been mostly on high ground, not in valleys. He believes that the eruptions are not caused either by excessive absorption of moisture or by gas explosions—the theories most readily suggested—but by land-slips, collapses, etc., of ground under the bog, which permit water or liquid mud to enter. This breaks up the bog mechanically, mixes with it and fluidifies it, and produces the outburst at the surface. The limestone formations in Ireland, with their large caverns and masses of water, are naturally subject to these collapses, which, with the vibrations they induce, are more frequent in wet years. The heavy rains preceding the bog eruptions are thus to be regarded as only an indirect cause of them. Herr Klinge supposes that similar eruptions occurred in past geological periods, the Carboniferous, for example, in some cases where fossil tree-stems are found in upright position.

NOTES.

In a paper in the British Association, on the Periodical Velocity of Bubbles in Vertical Tubes of Liquid, Mr. F. T. Tronton said that as a bubble ascended in a tube its changes of shape caused corresponding changes in its velocity, and consequently any given bubble if watched would be seen to have alternating *maxima* and *minima* of velocity. Further, the rush of water backward from the front to the rear of the bubble in the narrow channel between the latter and the wall of the tube was greatest when the bubble had its *maximum* elongation. By making the liquid more viscous we could arrive at a point where it became uncertain whether the bubble would ascend the tube in the long or flat condition, but having started either way it would continue in its original shape. At this particular viscosity the velocity of ascent was a *maximum*. Lord Kelvin, as Sir William Thomson is now called, suggested an application of this result to certain engineering problems, and particularly spoke of the possibility of nullifying the retarding effects of the viscosity of water upon the sailing of ships.

The Mexican jumping seed, or "devil's bean," is a euphorbiaceous plant of such poisonous properties that it is used by the Indians to envenom their arrow-points. It not having been scientifically identified to satisfaction, Dr. C. V. Riley has made a special study of it. The saltatory property is not intrinsic with it, but is imparted to it by an insect (*Carpocapra saltitans*), which secures lodgment within the bean and does the work. Dr. Riley believes that the insect is developed in the capsules of several species of the genus *Sebastiana*.

It is said that a larger cave than the Mammoth Cave, situated in the Ozark Mountains, near Galena, Mo., has been explored for a distance of more than thirty miles. In it have been found bones of recent and prehistoric animals, including the hyena and cave bear, and flint arrow-heads, but no bones of man. A few animals of the usual forms found in caves are still living there, including a white newt.

Phosphatic marls, according to the report of Mr. E. A. Smith, State Geologist, have been found in Alabama in the Cretaceous and Tertiary formations. When they were first brought to notice a spirit of speculation was aroused, which subsided when it was found that they did not include in commercial quantity high-grade phosphates suitable for exportation. Dr. Smith, however, regards this as to the advantage of the State, because it will cause the fertilizing material to be used at home, to the enlargement of its crops, as has occurred in New Jersey with its low-grade phosphates, instead of being exported as are the high-grade phosphates of South Carolina, which has, agriculturally, derived no more benefit than other States from its precious stores.

OBITUARY NOTES.

The eminent French philosopher and man of letters, Joseph Ernest Renan, died October 2d. He was the son of a sailor, and was born in Brittany, February 27, 1823. He was educated for the priesthood, and proved to be a remarkable student, but the result of his studies was to make him a theist instead of a Christian priest. His most widely known work is his Life of Jesus, which is one of a series of books on the origins of Christianity. He was also author of a History of the People of Israel, in five volumes, and wrote much on Oriental philology and archæology, in which subjects he was an adept. For many years he was Professor of Hebrew, Syriac, and Chaldaic in the Collége de France.

After some years of ill health, George Croom Robertson died September 20th, at the age of fifty-one. On account of illness he had recently resigned his professorship of Philosophy and Logic in University College, London, and gave up the editorial charge of Mind last year.